Aerofax Datagraph 4

Bell AH-1 *Cobra* Variants

by Kenneth Peoples

Bell Helicopter

AH-1W, BuNo. 162532

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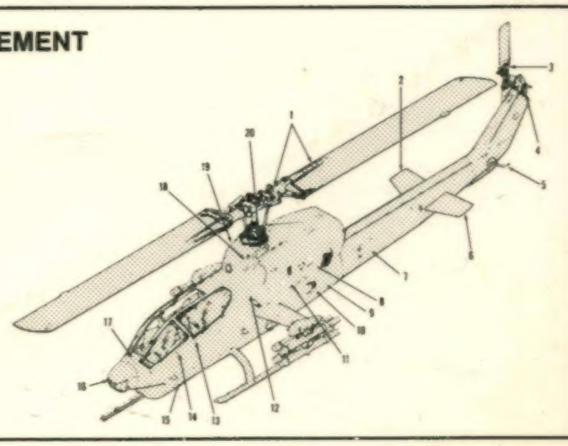
AH-1T GENERAL ARRANGEMENT

1. HUB AND BLADE ASSEMBLY
2. RIGHT SYNCHRONIZED ELEVATOR
3. TAIL ROTOR HUB AND BLADE
4. 90 DEGREE GEARBOX
5. TAIL SKID
6. LEFT SYNCHRONIZED ELEVATOR
7. AFT ELECTRONICS COMPARTMENT DOOR
8. ENGINE COMPOART (RH NOT SHOWN)
9. EXTERNAL POWER RECEPTACLE
10. ENGINE FIRE EXTINGUISHER ACCESS DOOR
11. TRANSMISSION COMPOARTMENT (RH NOT SHOWN)
12. HYDRAULIC COMPARTMENT DOOR (RH NOT SHOWN
13. FREE AIR TEMPERATURE GAGE
14. COPILOT/GUNNER DOOR SWITCH
15. AMMUNITION COMPARTMENT DOOR (RH NOT SHOWN)
16. TELESCOPIC SIGHT UNIT
17. RAIN REMOVAL DUCT
18. PITOT TUBE
19. PYLON ACCESS FAIRING
20. PYLON ACCESS DOOR (RH NOT SHOWN)



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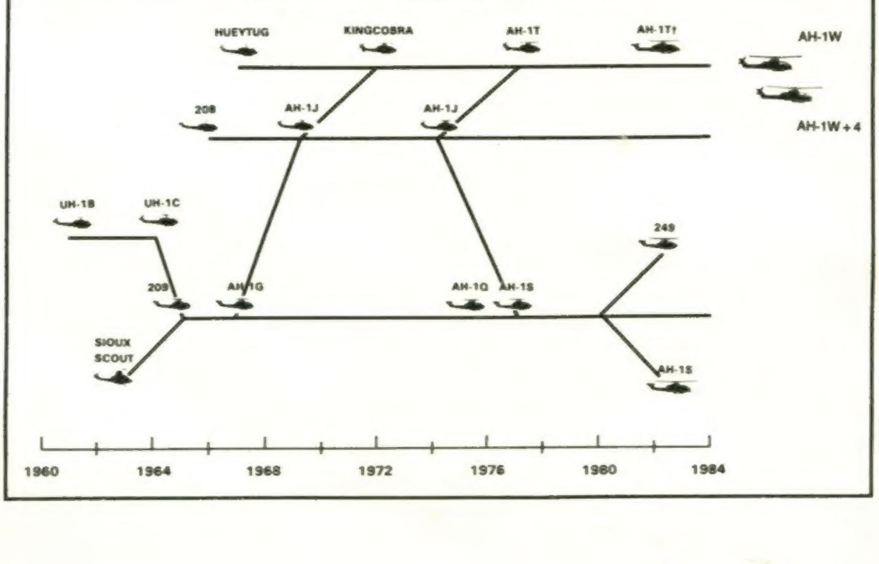
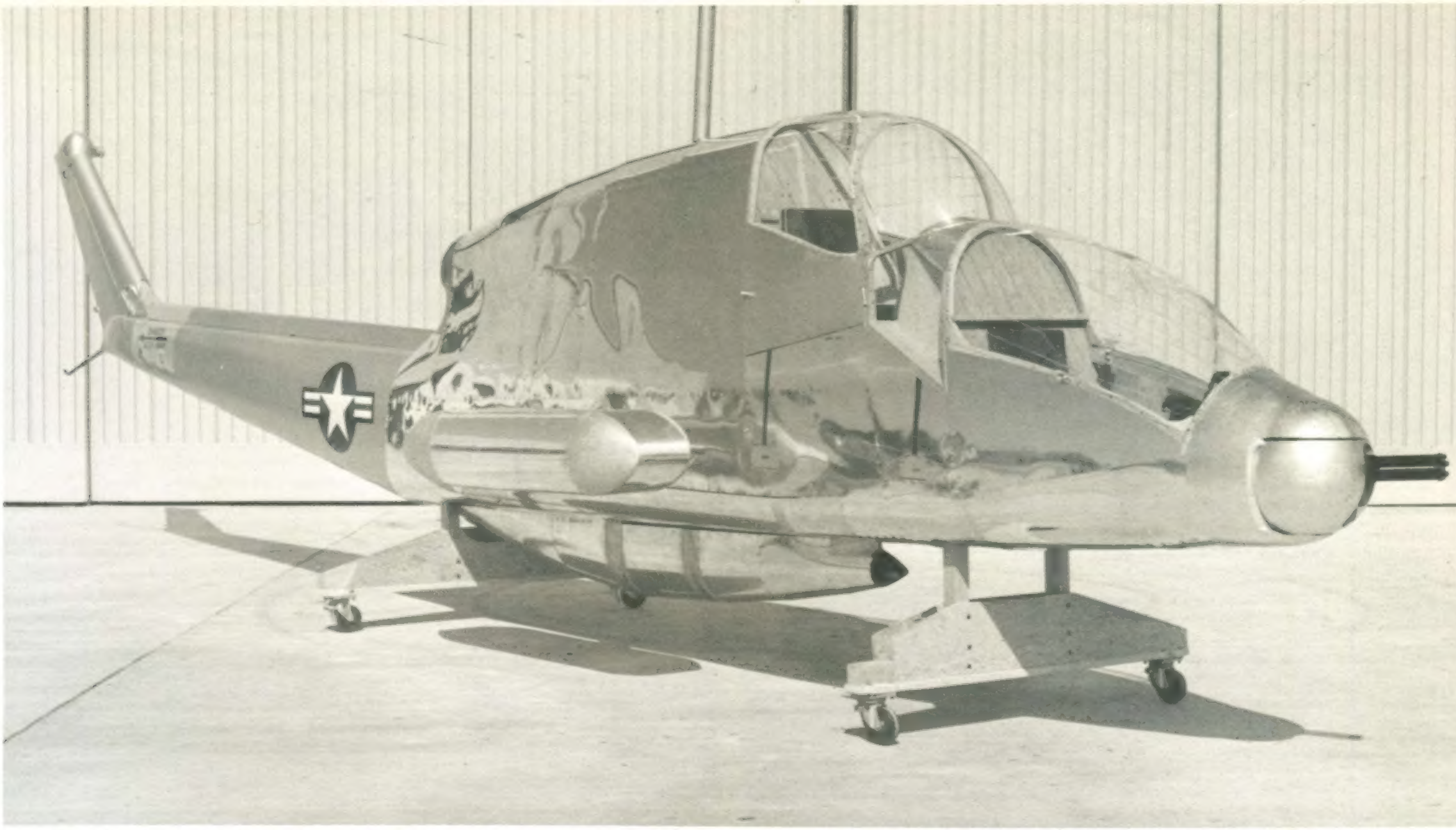
ABBREVIATIONS AND ACRONYMS:

AAFSS	Army Advanced Aerial Fire Support System
AAH	Advanced Attack Helicopter
a/c	Aircraft
ADF	Automatic Direction Finding
ADS	Air Data System
APE	Army Preliminary Evaluation
ARU	Attitude Retention Unit
AVIM	Aviation Intermediate Maintenance
AVSCOM	Army Aviation Systems Command
BIS	Board of Inspection and Survey
BIT	Built-In Test
CDS	Control Display Sub-system
C-LNAS	*Cobra* Laser Night Attack System
C-NAS	*Cobra* Night Attack System
CONUS	Continental U.S.
CPG	Copilot/Gunner
DARCOM	Development And Readiness Command
ECAP	Enhanced *Cobra* Armament Program
EECU	Engine Electrical Control Unit
EPS	Electronic Power Supply
FCC	Fire Control Computer
FFAR	Folding Fin Aerial Rocket
FLIR	Forward Looking Infrared
FMF	Fleet Marine Force
FMS	Foreign Military Sales
FOD	Foreign Object Damage
FY	Fiscal Year
G.E.	General Electric
GHS	Gunner Helmet Sight
HE	High Explosive
Hellfire	Helicopter-launched fire and forget
HMU	Hydro-Mechanical Unit
HOGE	Hover Out of Ground Effect
HUD	Head Up Display
IAI	Israel Aircraft Industry
ICAM	Improved *Cobra* Agility and Maneuverability
ICAP	Improved *Cobra* Armament Program
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMRB	Improved Main Rotor Blade
IOT&E	Initial Operational Test and Evaluation
IR	Infrared
JDA	Japanese Defense Agency
JGSDF	Japanese Ground Self Defense Force
LLTV	Low Light Level Television
LOAL	Lock-On After Launch
LOBL	Lock-On Before Launch
LOS	Line Of Sight
LRF	Laser Rangefinder
LZ	Landing Zone
MAGTF	Marine Air Ground Task Force
MFT	Material Fielding Team
mm	Millimeter
MOD	Modernized
MRTU	Multiplex Remote Terminal Unit
NARCADS	Navy Armament Control and Delivery System
NASA	National Aeronautics & Space Administration
NET	New Equipment Training
NETT	New Equipment Training Team
NOE	Nap-Of-the-Earth
NOS	Night Observation/Surveillance
NPE	Navy Preliminary Evaluation
NTS	Night Targeting System
NVG	Night Vision Goggles
OSD	Office of the Secretary of Defense
OSIP	Operational Safety and Improvement Program
PASS	Priority Aircraft Subsystem Suitability
PIP	Product Improvement Program
R & D	Research and Development
RAM	Reliability, Availability, and Maintainability
RFP	Request For Proposal
RMS	Rocket Management Subsystem
RWR	Radar Warning Receiver
SCAS	Stability Control Augmentation System
shp	Shaft horsepower
SSG	Special Study Group
TERF	Terrain Flight
THCDS	TOW/*Hellfire* Control and Display Subsystem
TMDE	Test Measurement and Diagnostic Equipment
TOW	Tube-launched, Optically-tracked, Wire-guided
TRADOC	Training and Doctrine Command
TSARCOM	Troop Support and Aviation Material Readiness Command
TSU	Telescopic Sighting Unit
USAAEFA	U.S. Army Aviation Engineering Flight Activity
UHF	Ultra-High Frequency
USMC	United States Marine Corps
USN	United States Navy
VC	Vietcong
VHF	Very-High Frequency
VOR	Visual Omni-Range
VSS	Vibration Suppression System

BELL AH-1 PRODUCT HISTORY





Bell Helicopter

The original Bell Model D255 "Iroquois Warrior" mock-up was extraordinarily innovative for its time and was perhaps the first dedicated attack helicopter design to feature what now is the commonly accepted armed helicopter stepped cockpit configuration. The latter placed the pilot behind the gunner, thus giving the latter a clear target field of view while permitting the former the visibility normally required for unequivocal control of the aircraft.

CREDITS:

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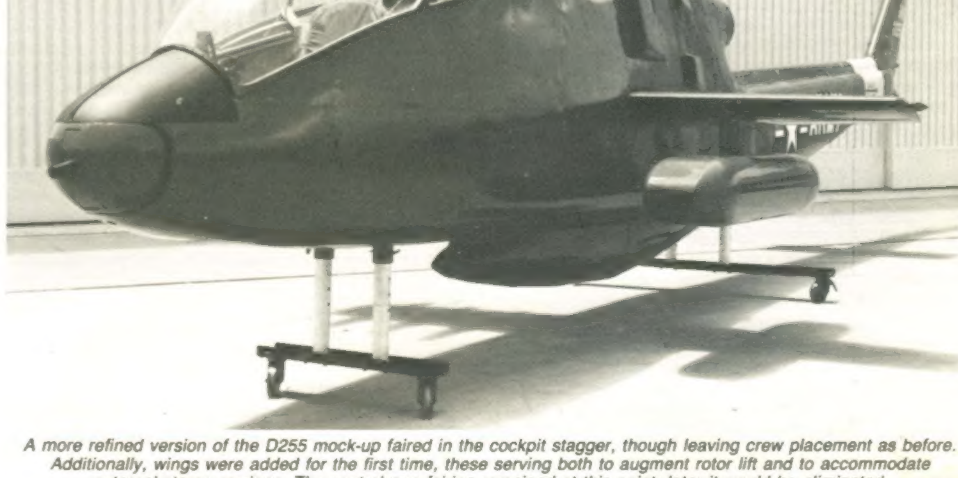
Most of all, the author wishes to thank the women in his life: Kathie and Kelly Peoples. Their understanding, patience and support made the writing of this book a true labor of love.

PROGRAM HISTORY:

Bell Helicopter Textron's AH-1 *HueyCobra* undoubtedly ranks as one of the world's truly great helicopter designs. Hurriedly conceived in response to urgent wartime demands, this remarkable gunship went from drawing board to battlefield in less than eighteen months. While the *Cobra's* development time may have been short, its longevity has proven to be extraordinary. Beginning with the premier AH-1G of Vietnam fame, the basic *Cobra* design has been modified, updated, and refined to the point, where, today, with the advent of the awesome AH-1W *SuperCobra*, it represents one of the most lethal armed helicopters in the world. After more than two decades of faithful service, the classic *Cobra* remains the single most successful dedicated attack helicopter ever produced.

The genesis of the AH-1 can be traced back to an in-



Bell Helicopter

A more refined version of the D255 mock-up faired in the cockpit stagger, though leaving crew placement as before. Additionally, wings were added for the first time, these serving both to augment rotor lift and to accommodate external stores carriage. The ventral gun fairing remained at this point; later it would be eliminated.

Bell Helicopter

Wooden mock-up of the Model 207 "Sioux Scout" was built to ascertain equipment placement and Model 47 parts relationships. Staggered seating attributes would be explored in hardware form with the finished aircraft for the first time.

Bell Helicopter

Parts from a commercial Model 47J-2 and a military OH-13S were utilized in building the one-off Model 207. Sans armament and as shown, this aircraft flew for the first time on June 26, 1963. Lengthy test boom later was removed.

Bell Helicopter

Following the completion of initial flight trials, the Model 207 was modified to incorporate the first of several different wing configurations. These served to partially alleviate rotor loads in horizontal flight.

Bell Helicopter

In its definitive form, the Model 207 mounted short, tapered wings and a privately funded Emerson Electric TAT-101 turret below its nose. The turret, which was linked to the movement of the gunner's sight, mounted twin 7.62mm M-60C machine guns.

novative Bell design first unveiled at Fort Bragg, North Carolina during June 1962. At that time Bell invited high-ranking Army officials to their Ft. Worth, Texas facility to inspect the mock-up of what was then a radical new helicopter configuration. Although the mock-up represented a totally new dedicated attack helicopter design, Bell proposed that the new machine utilize the Lycoming T-53 turbine and other dynamic components from the highly successful Bell UH-1 utility helicopter in order to ensure Army inventory commonality and cut development time.

Known within Bell as the Model D255 *Iroquois Warrior*, the AH-1 *HueyCobra* series predecessor looked more like a fighter aircraft than a conventional helicopter. The mock-up featured a low-drag, narrow fuselage made possible by a stepped tandem seating arrangement in which the gunner was positioned ahead of and below the pilot. Additional aerodynamic refinements were provided in the form of retractable landing skids and a distinctive "doghouse" upper fairing designed to enclose the main rotor gearbox and swash plate mechanism. The tailboom and vertical fin configuration were unmistakably UH-1 in origin. Proposed armament consisted of a gun turret integrated into the fuselage nose, a belly-mounted weapons pod, and armament-carrying stub wings fitted to the fuselage aft of the pilot's station.

The Bell design was, indeed, impressive, but so-called "conservative elements" within Army aviation ranks were reluctant to embrace such a radical new machine. Instead, they favored the continued development of multi-purpose machines such as Bell's UH-1A/B which was considered to have substantially more utility than a "pure" attack design. But already the winds of change had begun to blow in Washington.

On April 19, 1962 Secretary of Defense Robert McNamara delivered to Secretary of the Army Elvis J. Stahr, Jr. a memorandum in which he was critical of the Army's apparent "conservatism" regarding its aviation procurement program. McNamara urged Stahr to re-examine the Army's tactical mobility requirements, suggesting the service's plans include what he termed "fresh and perhaps unorthodox concepts". The result of the Secretary's now famous memo was the Army's formation of the "Howze Board". This special review board, composed of general officers and notable civilians (including such well-known individuals as aircraft designer and aviation consultant Ed Heinemann; the Rand Corporation's Dr. Edwin Paxson; and Frank A. Parker, Jr., President of the Research Analysis Corporation), completed its work in 90 days and submitted its final report on August 30, 1962. By endorsing the creation of so-called "air cavalry combat brigades" and the aircraft needed to support such organizations, the Howze Board report provided impetus for the further development of attack helicopters.

In spite of the Army's initial coolness toward a dedicated attack design, Bell decided to go forward with the company funded *Warrior* program. Although some company personnel believed that only an aerodynamic prototype was needed at the time, Bell management made the decision to construct a flying testbed in the hope that such a machine would spur thinking and get an attack helicopter program beyond the mock-up stage. Time and cost were of primary importance. Rather than expend the time necessary to build an expensive flying Model D255 prototype, the company elected to produce a less sophisticated surrogate aircraft by extensively modifying one of its piston-engine Model 47s (OH-13S).

The reconfiguration of this testbed machine got underway during December 1962. Known as the Model 207 *Sioux Scout*, it utilized the rotor dynamic system and 260 hp Lycoming turbo-supercharged TVO-435-B1A powerplant of the OH-13S and a center section, tailboom, and modified fixed skid-type landing gear from a commercial Bell Model 47J-2. The forward (cockpit) section of the helicopter was fashioned largely from reinforced plastic skinning. The aircraft featured the stepped tandem seating arrangement similar to the Model D255, with the crew enclosed in a half-shell type plexiglass canopy.

The Model 207 received dual flight controls with the pilot having a conventional cyclic, collective and anti-torque control system. In order to accommodate the floor-mounted, hand-held gunner's sight, standard cyclic stick and directional control pedals were shelved in favor of a unique side-arm control system mounted on arm-rest style pedestals: a short-throat collective with a motorcycle style twist grip throttle was positioned on the gunner's left and a pistol grip controller was installed on the right side to provide pitch, roll and yaw control (the device actually was twisted by the gunner to achieve yaw, or directional control). So configured, the experimental aircraft demonstrated flight characteristics very similar to its Model 47/OH-13S parentage, but precise control inputs were required from the front-seat driver due to the shorter leverage (reduced travel) of the side-arm flight system.

Armament for the *Sioux Scout* was the privately-funded Emerson Electric TAT-101 turret installed below the aircraft's nose (this same chin turret later was employed on the USMC UH-1E). Mounting twin 7.62mm M-60C machine guns, the new turret was linked to the movement of the gunner's sight. To provide maximum fire-power flexibility, the gun turret swiveled 200° in azimuth and demonstrated an elevation/depression range of +15° to −45°. When returned to the fixed-forward position, the pilot also could fire the turret by maneuvering the helicopter on the target. The gunship's fire control system consisted of a pantograph sighting unit (similar to that employed on UH-1A/B aircraft) fitted with pistol grip fire controls on either side of the sight head.

Stub wings were mounted high on the fuselage aft of the cockpit and served a variety of purposes. Although originally designed to hold auxiliary fuel cells and provide the little gunship with increased climb capability, flight testing revealed that the new wings also helped improve high-speed turning capability while delaying unwanted vibration. Bell also proposed using the stub wings as platforms for additional armament, an idea subsequently incorporated into the AH-1 design.

Civil registered as N73927, the Model 207 completed its first 15 minute ground run on June 26, 1963, and the following day Bell test pilot Al Averill took it up on its maiden 50 mph, 10 minute flight. On July 2 and 3 Averill put it through two shakedown flights of 90 and 105 mph each and conducted various tests to ensure that sufficient engine cooling was being accomplished during hovering flight. The aircraft received its first paint job on July 10 and subsequently was demonstrated for Bell employees at the Hurst plant the same day. By July 25, 1963 Averill had test flown the diminutive helicopter 18.5 hours during which time various engine cowlings, intake baffles, stabilizer bar dampers, tailboom elevators, and vertical and ventral fin configurations were evaluated.

During September 1963 Bell sponsored a two-day research and development symposium for military and NASA personnel at its Hurst, Texas facility. Naturally, the

demonstration of the *Sioux Scout* was a feature attraction of the event. After touring several Army installations during the fall of 1963, Bell turned the testbed over to the Army for further evaluation. Pilots of Troop B, 3rd Squadron, 17th Cavalry (AIR) of the 11th Air Assault Division at Fort Benning, Georgia were chosen to put the little gunship through its paces. During January 1964 these same pilots produced a glowing report extolling the virtues of the Model 207 and recommending the prompt development of a special purpose attack ship of *Sioux Scout* configuration. They argued, however, that the operational machine should be built around a turbine engine and dynamic system similar to the UH-1 in order to improve performance and increase armament capability.

Encouraged by the Army aviators' enthusiastic report, Bell returned to the drawing board. While all agreed that a new attack helicopter should be powered by a turbine engine, Bell engineers decided the original Model D255 was simply too large for the available T53-L-11 powerplant. If the standard UH-1 engine and dynamics were used, the *Warrior* would have to be scaled-down accordingly. The resultant re-design, officially designated the Model D262, was completed in time to be entered in the Army's Advanced Aerial Fire Support System (AAFSS) competition held during the latter half of 1964. Unfortunately for Bell, the Army announced six months later that it had selected Sikorsky and Lockheed to compete in developing the advanced machine.

Model 209 Concept Demonstrator

On Saturday, February 20, 1965, Charlie Seibel, Bell Helicopter's Chief Experimental Projects Engineer, learned that Bell's entry had been eliminated from the AAFSS competition. Though disappointed, Seibel was not particularly surprised. The Model D262 had never been designed to meet the sophisticated specifications outlined in the Army's RFP of July 1964. He immediately placed a call to fellow engineer Bob Duppstadt at home to give him the bad news, but also took the opportunity to say that he believed Bell's most recently discussed project—the company confidential Model 209—would become a "hot item". Given the long lead time the AAFSS project would require, Seible believed, and rightly so, that the escalating war in Vietnam would necessitate the development of an "interim" attack helicopter to meet the Army's immediate combat needs. The events that would transpire over the next six months would prove Charlie Seibel's assessment to be correct.

The anticipated need for an "interim" gunship was first recognized and discussed at Bell's internal management meetings as early as August 1964, barely a month after the Army released its AAFSS RFP. Although the possibility of Bell being eliminated from the Army competition was acknowledged, the company proposed to take a watch-and-see attitude pending the Army's review of the dozen designs submitted by industry. Several internal meetings were conducted in the fall during which time an "interim" design was discussed, but it was not until December 16, 1964 that a formal marketing briefing was prepared for upper management to outline the Model 209 requirement and opportunity. At that time engineers Seibel and Duppstadt joined Cliff Kalista, Manager of Military Applications, and Bell Vice President of Military Contracts Hans Weichsel in arguing the merits of an "interim" gunship project. While Seibel and Duppstadt could offer some input regarding possible design configurations, their task was complicated by the fact that they were proposing a company-funded program for which there was no immediate military requirement. The meeting concluded with Bell President E. J. "Duke" Ducayet giving approval to a go-ahead plan for initial design work on the proposed Model 209—the forerunner of the AH-1G *HueyCobra*.

It was about this same time that Bell hit upon its official name for the Model 209. Contrary to what some might believe, the AH-1 was not named for Bell's World War II vintage P-39 *Airacobra* or P-63 *Kingcobra* fixed wing aircraft. While the various actors tell slightly different versions of how the helicopter got its name, most agree with the general chain of events herein recounted. According to Cliff Kalista, the original role envisioned for the proposed machine was essentially that of an armed scout helicopter, i.e., an aircraft capable of performing armed reconnaissance and other security-related missions. Consequently, during the early internal meetings it seemed natural to refer to the aircraft as the UH-1 *Scout*—obviously a name inspired by the HU-1 *Warrior* and *Sioux Scout*.

By late 1964, however, the Model 209 had acquired the unofficial name of UH-1 *Cobra*. A. G. "Dean" Stravato, Director of Operations at Bell's Amarillo, Texas facility, is convinced that the name change was a product of Hans Weichsel's 1964 tour of Army installations in Vietnam—a view that is to some extent supported by Cliff Kalista. According to Stravato, he was serving as a company technical representative in Vietnam when the Army's 114th Airmobile Company arrived. This unit, part of the Delta Battalion, was the first *Huey* company to be sent directly from the United States to Vietnam. The company was divided into three platoons, with the 3rd platoon made up of armed UH-1Bs. While visiting the company's home turf at Vinh Long, Weichsel asked Stravato what the gun platoon called themselves. Stravato answered that they were known as the "Cobra Platoon". Weichsel immediately liked the name; and hence, is credited with carrying it back to Ft. Worth.

Although helicopter enthusiasts the world over have come to associate Bell's remarkable gunship with the moniker *Cobra*, it was neither the final nor official nomen given the aircraft. By all accounts, the man responsible for giving the AH-1 its official name was none other than General Hamilton H. Howze of "Howze Board" fame. As Cliff Kalista recalls, one day "Ham" Howze, then retired and working for Bell, walked into Kalista's office and suggested that the new helicopter be christened the UH-1 *HueyCobra*. General Howze's name stuck, and the U.S. Army later adopted *HueyCobra* as the aircraft's official nomenclature.

Interestingly enough, the Army had less trouble deciding on what name to give the helicopter than what its official designation was to be. It first referred to the aircraft as the UH-1H (later used for the H model UH-1 produced from September 1967 to July 1982), but then requested assignment of WH-1G as an appropriate designation ("W" representing weapons, "H" for helicopter, "1" to remain as the 1st series, and "G" as the latest model due to the fact that Bell had already offered its proposed UH-1F *Huey* to the AF). Six weeks after placing its first order for 110 production aircraft, the Army modified its contract with Bell and changed the helicopter's designation from UH-1H to AH-1G ("A" for attack). Finally on July 13, 1966, another contract modification was issued making the new gunship officially the AH-1G *HueyCobra*.

After learning that its design had been eliminated from the AAFSS competition, Bell wasted no time making the decision to go forward with the Model 209 Program. Bell President E. J. "Duke" Ducayet called a management meeting for March 5, 1965. Key players in attendance at the six-hour meeting included Vice Presidents Bart Kelley and Jim Atkins; Robert Lichten, Charlie Seibel, Bob Duppstadt and Phil Norwine from Engineering; Hans Weichsel, Vice President Military Contracts and Cliff Kalista, Manager Military Applications. This august group knew they had an excellent chance to market the Model 209 if the proposed aircraft could be developed quickly. It was decided to go ahead, but the new machine would have to be completed in six months at a cost of no more than $1 million. As it turned out, the prototype was finished ahead of schedule and just $40,000 over budget. As a result of the meeting, the following basic ground rules were established:

- The Model 209 would employ the 44 ft. Model 540 "doorhinge" rotor system and dynamic components from the UH-1C then on the production line (UH-1Cs were first delivered to the Army during June 1965).
- A 7.62mm minigun turret would be the prime armament with space for 6,000 rounds (only 4,000 rounds of linked ammunition would actually be carried).
- Each wing would have two hard points; one hard point on each wing would be live.
- In the interest of saving weight and reducing aerodynamic drag, no stabilizer ban would be used on the rotor hub. Instead, Engineering was directed to install an electronic Stability Control Augmentation System (SCAS) to provide the proper controllability and stability.
- The ship should have a maximum speed of 175 knots in a clean configuration (i.e., minigun turret and "clean" wings).
- Maximum gross weight should not exceed 7,000 lbs. with 1,200 lbs. of fuel, and the aircraft should meet or exceed the 6,000 ft., 95° day hovering requirement.
- The demonstrator initially would be fitted with the Lycoming T53-L-11 engine from the UH-1C, but was expected to be retrofitted with the then experimental L-13 whenever the engine became available during 1965 (the new 1400 shp turbine actually was utilized in the Model 209 during the fall of 1965 and entered military production during 1966).
- The Model 209 would feature a skid-type retractable landing gear.

The landing gear configuration was a subject of much discussion and subsequent engineering study. Cliff Kalista pushed for a retractable gear because of the novelty of marketing the ship that way. Charlie Seibel countered by arguing, from an engineering perspective, that the more complicated retractable design would not improve performance sufficiently to justify the increased cost or weight (design studies later showed the gear up position only improved the machine's performance by about 3 knots). There were other questions: Would the retractable gear really allow more turret azimuth angle of fire, or would it be found that the stops would have to be set to prevent destruction of the gear when extended? Would dropping of wing stores only when the gear was retracted be acceptable, or should this operation proceed also with the gear extended? Would the average helicopter pilot, accustomed to fixed gear, remember to extend the gear? In the interest of answering these questions and also confirming the performance tradeoff, "Duke" Ducayet made the decision to go with a retractable gear. After all, the ship could be tested as a retractable or fixed gear configuration.[1]

The meeting concluded with agreement on a target time schedule: roll out of Bell's ship number 20001 was to occur by Labor Day with the first flight no later than October 1. The ship was to be ready for military demonstration by November 1, 1965. The Model 209 Program was to be a "company confidential" project carried out behind closed doors. Only those directly involved were to have access to the construction area, and all internal correspondence regarding the ship was to carry the "CONFIDENTIAL BELL CLASSIFICATION" stamp. The Experimental Department hangar (hangar #45) was the designated work site, and shop superintendent Red Woodall was directed to build walls inside the hangar to establish what was called a secure "green room". Program management was handled by Jim Atkins, with Marty Vale acting as secretary. Weekly, representatives from all affected groups and departments were to meet and report on programs and problems.

Chief Experimental Projects Engineer Charlie Seibel was designated to direct the Model 209's development and was assisted by engineers Bob Duppstadt and Mike Folse. At the height of the Model 209 Program, Seibel's crew consisted of over 40 primary engineers, supported by 17 engineers from other groups. This highly motivated group was treated to morning visits from E. J. Ducayet on almost a daily basis.

March 10, 1965 was selected as the start-up date for the Model 209 project, and Sales Order 4279-1-2 was officially issued for the new ship. Charlie Seibel convinced E. J. Ducayet that Bell should utilize the talents of a consulting industrial designer (probably a first for the industry) on the project. Initially Ducayet was less than enthusiastic, but finally gave in to Seibel's request, while warning that no more than $5,000 was to be spent in consulting fees. Seibel employed designer Richard Ten Eyke (formally with Cessna Aircraft) and told him to come up with a helicopter design that "looked like it was going 200 knots just sitting on the ground". Ten Eyke completed preliminary renderings of the proposed ship in both the fixed and retractable gear configurations, and the Bell crew took it from there. The mockup was completed during March and the first Model 209 drawings were released on April 8, 1965.

The Model 209 featured the tandem-seat forward fuselage design pioneered on the D255 and flight tested on the Model 207 *Sioux Scout*. Slightly over three feet wide, the fuselage interior configuration received major study early in the program. With the internal space reduced to less than half of the previous UH-1 models and with the requirements for additional fuel, equal equipment, and good access, the problem was acute. Although a monocoque structure was considered, it was rejected due to poor accessibility. The use of internal beams and honeycomb panels provided the necessary airframe stiffness and allowed space outside the beams for controls, ducts, wire bundles, and other equipment. With nonstructural exterior panels, these items were easily accessible. The honeycomb floor served as a structural mount for the chin turret and helped to minimize vibration and absorb turret recoil loads.

In the central fuselage area the space requirement for fuel, transmission, and controls dictated that the structural beams be at the airframe contour. A transition from contour beams to interior beams was accomplished just forward of the stub wings in the forward fuel tank area.

[1] Subsequent testing on the Model 209 confirmed that the retractable gear would not offer advantages in weapon angle coverage or wing stores jettison. It did, however, introduce safety and maintenance disadvantages. As the operational studies progressed, it became clear that the turret coverage could not satisfactorily include the extended gear envelope, and the slight speed advantage did not justify the many associated disadvantages of a retractable configuration.

The contour beams then were extended rearward to the tailboom attachment and with the engine compartment deck and fuselage bottom, formed a semi-monocoque structure. The aircraft's tailboom structure was inherited from the UH-1C and featured the larger cord vertical fin which had been given the distinctive anti-torque camber to provide high directional stability and most of the lifting rotor torque reaction at high cruise speeds.

In order to optimize aerodynamic efficiency all rivets and screws on the forward fuselage were flush mounted, antennas were mounted flush or submerged, and drain lines were "ganged" inside to reduce the number of external drains. To avoid aerodynamic stall, a non-metallic pylon or "doghouse" fairing (similar to the one on the D255 mock-up) was used to enclose the rotor mast, swashplate, and several antennas. While a stalled region did exist behind the mast and pitch links, this area was aerodynamically isolated to prevent stall precipitation of the pylon fairing by incorporating a distinctive "surfboard" on top of the pylon. The design was finished off with a spinner attached to the mast to close the opening in the top of the fairing.

Likewise, considerable attention was given to the design of the aircraft's stub wings so as to offer minimum drag at high forward speed. Although the wings did provide minimum lift and contribute to the helicopter's maneuvering capability, their primary purpose was to support the external weapons. The design of this support was dictated by fatigue strength considerations and stiffness. High stiffness was required to avoid resonance at the second harmonic rotor frequency with the various wing stores proposed. In order to place the natural frequency of the wings above two-per-rev with a maximum load of 2,200 lbs. mounted on the wing, the required stiffness became the designing factor. The wing panels were attached to the fuselage carry-through beams with five bolts, and each carry-through beam was constructed of a single piece forging. Likewise, each wing span from the fuselage attachment point to the tip was a single forging.

The Model 209 was designed to incorporate the new uprated T53-L-13 powerplant (re-designed L-11) then under development by Lycoming. By redesigning the initial two stages of the L-11 copressor to accept new transonic blades, providing variable-incidence guide vanes to improve compressor performance, and increasing the engine from two to four stages, the manufacturer was able to increase airflow, lower engine temperatures, and boost the new powerplant's maximum rating to 1400 shp. When installed in production *HueyCobras*, the L-13 turboshaft engine was derated to 1,100 shp (continuous) so as to provide the desired "hot-and-high" performance margins.

The availability of a complete transmission (1100 shp) tail rotor drive system and main and tail rotor systems from the UH-1C simplified the construction of the Model 209. The 8 ft. 6 in. bonded metal tail rotor was of the two-blade, rigid, delta hinge type, having a rotor speed of 1654 rpm. The 44 ft., two-blade, semi-rigid, seesaw type main rotor also was constructed of bonded metal and demonstrated a maximum power on speed of 324 rpm. Tip speed was 746 ft./sec. Known officially within the company as the 540 rotor, the so-called "doorhinge" system was designed by Bell engineers to provide greater simplicity, lower maintenace, and improved performance. The system had been extensively flown on a Model 204 since 1963 and had consistently demonstrated a marked improvement in vibration and loads at high speeds. In addition, the simpler, cleaner rotor hub used on the new system provided a drag reduction that was estimated to save as much as 50 hp at 140 knot speeds.

The unique 540 system utilized a roller-type feathering bearing for attaching the blades to the hub and new Teflon bearings that required no lubrication. The wide cord rotor blades (27-in.) provided the prototype *HueyCobra* with the increased blade area necessary for high thrust capability at high forward speeds. Hence, fitted with the new system, the aircraft was able to demonstrate excellent "g" capability to accommodate its high speed maneuvering requirements. The 540 system also constituted an important breakthrough in the reduction of second harmonic rotor vibration characteristic of two-blade rotors—primarily a result of combining heavy blade tip weights with the flex-beam configuration of the rotor hub.

The new gunship was fitted with flight controls similar to those pioneered on the *Sioux Scout*. The pilot's station was equipped with conventional helicopter flight controls, but, again, the floor-mounted pantograph sight prevented the installation of standard cyclic and collective controls for the gunner. Front-seat piloting capability was provided by side-arm controls installed on the cockpit consoles. The cyclic control, located on the gunner's right, operated through approximately one-half the normal stick travel and carried a trigger switch for operation of the turret while in a stowed (fixed-forward) position. The collective controls, located on the left console, also operated with reduced travel and accommodated a twist grip for manual operation of the engine. Unlike the Model 207, however, the gunner was provided with conventional anti-torque pedals. All flight controls were fitted with dual hydraulic boost.

As mentioned earlier, in order to save weight and reduce drag, the Model 209 was not fitted with Bell's traditional rotor hub-mounted stabilizer bar. To provide the proper control and stability, an electronic Stability Control Augmentation System (SCAS) was installed. The SCAS operated in pitch, roll, and yaw, and provided a high degree of stability and controllability without one characteristic compromising the other. Actuators were installed within the separate control systems to provide desired inputs simultaneously with and independent of the pilot's inputs. Control position information was supplied to the SCAS by means of electric pots located on the controls and rate gyros supplied the SCAS with motion rates in pitch, roll, and yaw. Hence the unit was provided with the necessary information to distinguish between aircraft disturbances which were of pilot origin and those from external causes. Pilot originated control inputs actually were amplified initially and later damped to obtain the desired response rate. The net result was an aircraft with a very high degree of dynamic stability and immediate response to pilot control inputs.

The management of internal airflow within the aircraft also was a careful design consideration. Early engineering studies indicated that the ram recovery of engine combustion air was not beneficial under the majority of flight conditions. Because the L-13 powerplant was to be derated to 1,100 shp, the benefit from ram air recovery was expected to be limited to a condition of maximum speed at a temperature-altitude condition where less than 1,100 shp would be available. The solution was to extract low energy air from the external flow about the helicopter. This was accomplished by taking aboard as much boundary layer air as possible via specially designed, partially submerged vertical intakes on each side of the engine cowling.

Equally important was the exit design which accommodated the internal air flow. Exits were designed to direct the flow rearward and accelerate the flow as much as possible. As designed, the engine combustion air left through the engine exhaust, and the engine compartment cooling flow was actually augmented rearward by the exhaust. The oil cooler airflow, cabin ventilation air, and transmission compartment airflow were accelerated through a rearward exit below the engine exhaust by a mechanically driven axial flow fan.

Thoughout the spring of 1965 work continued in the "green room" at a feverish pace. Outstanding esprit de corps existed among all hands and was fostered by management in this seemingly do or die effort to recuperate after losing the AAFSS competition. Dedicated Bell employees often worked around the clock to iron out engineering and construction glitches and keep the program on schedule. Construction of the new gunship was punctuated with a good deal of improvising. For example, when it was discovered that aluminum extrusions for the fuselage beams could not be manufactured in time, the construction team bonded up thin layers of sheet metal to duplicate the struction of an extrusion. Also, ventilation ducts were not designed on paper prior to beginning construction. Therefore, during the actual fabrication process the ducts were hand cut and shaped from styrofoam and wrapped in an epoxy and fiberglass coating. Once the outer covering had set up, an acetone solvent was poured into the ducts to wash out the styrofoam and create the actual air passages.

As the spring gave way to another hot Texas summer the Model 209 demonstrator really began to take shape. The project received added impetus when, during June 1965, the Army announced that it would seek an "interim" gunship to meet its immediate combat need in Southeast Asia. On June 12, 1965 the Commander, Military Assistance Command, Vietnam indicated his concern about the growing Viet Cong threat against helicopter assault operations and directed Brig. Gen. John Norton, Deputy Commander of U.S. Army Support Command, Vietnam, to study the problem. In its report, General Norton's study group highlighted two major problems: first, the Viet Cong had introduced larger 12.7 mm machine guns and were expected to bring in even heavier 37 mm anti-aircraft weapons by year's end. Secondly, there was an urgent need for faster armed escort helicopters. The UH-1s then in use were simply too slow to keep up with the transport helicopters due to the additional weight of armament. What was needed was an armed helicopter capable of maintaining a speed of at least 150 knots.

Although the Army's planned AAFSS machine was viewed as the solution to the escort problem, its availability was still years away. After reviewing the various options, the Army settled on a compromise plan: the development of the AAFSS would go forward, but in the meantime an "interim" gunship would be sought—one that could be on the battlefield within twenty-four months. Consequently, Col. Harry L. Bush, Army Material Command, was charged with forming a group to evaluate and select an aircraft which offered the most significant increase in capabilities over the armed UH-1.

Bell wasted little time in proposing the Model 209. On August 18, 1965, company representatives made a formal presentation to the "Bush Board", during which the Model 209 was offered as an "off-the-shelf" alternative to the armed UH-1 the Army then was purchasing to replace Vietnam attrition. In fact, they argued that the high speed *HueyCobra* was not a "new" aircraft at all. Rather, it represented a modified version of the UH-1B[2] which could be readily deployed directly from production to field units equipped with the UH-1 series helicopters. They went on to point out that the aircraft would require reduced flight testing time, and transition for pilots and mechanics would be simplified due to the similarity of dynamic systems and flying characteristics between the new gunship and the familiar UH-1B.

Meanwhile, back at Ft. Worth the Model 209 manufacture was nearing completion. On the very day Bell made its presentation to the Army, the *HueyCobra's* fabrication was finished. The only major tasks left were to install the canopy transparencies and main and tail rotors. In the interest of affecting an efficient transfer to Flight Test and expediting the necessary preflight tasks, Charlie Seibel issued a roll-out schedule memo to all concerned personnel. At 6:00 a.m. on September 2, 1965 the Model 209 was rolled out of the Experimental Department hangar on its way to the paint shop. Two days later, on September 4, the new gunship was weighed (actual was 4,190 lbs. including instrumentation), and at 10:00 a.m. that same morning the aircraft was moved by covered truck to Carter Field flight test where controls proofloading was started and rotor installation and rigging was accomplished.

At 7:30 a.m. on September 7, 1965, the Model 209 carried out its initial ground run, and at 5:30 p.m. the new gunship lifted off on its twelve minute maiden flight with Chief Experimental Test Pilot Bill Quinlan at the controls. Duly registered as experimental aircraft N209J, the prototype *Cobra* was flown by Quinlan the following day on a shakedown to 90 knots, and on September 9 the helicopter achieved 162 knots with the landing gear in the down position. During mid-September Bell went public with its latest design, inviting the local press and national journalists to view the new gunship. During the week of September 20, 1965 *Aviation Week & Space Technology* ran a feature story on what it termed the "fire support version of the UH-1B". The month was crowned with the arrival in Ft. Worth of several Army officials, including Maj. Gen. George P. Seneff, Jr., who made the service's first qualitative evaluation flights in N209J on September 23, 1965.

Bell continued *Cobra* flight testing throughout October while waiting for the Bush Board to deliberate. Five different aircraft had been offered for consideration: the Navy's Kaman UH-2 *Seasprite*, the Army's Boeing Vertol CH-47 *Chinook*, Piasecki's Model 16H *Pathfinder*, the civil Sikorsky Model S-61 *Sea King*, and of course Bell's Model 209 *Cobra*. The *Pathfinder* and giant *Chinook* already had been eliminated and, given the Army's enthusiastic response to evaluation flights during September, Bell hoped for a quick and favorable decision on the *Cobra*. It was not to be. The Army announced that a competitive fly-off competition was to be held among the remaining three aircraft at Edwards AFB, California during November.

Prior to competing in the comparison testing, it was necessary to make an important modification to the new gunship. Flight testing had revealed a rolling lateral vibra-

[2] Apparently the logic of this argument rang true with the Army. When the decision was made to acquire the *HueyCobra*, the service elected to procure the aircraft via an Engineering Change Proposal (ECP) to the UH-1B rather than a standard new aircraft production contract.

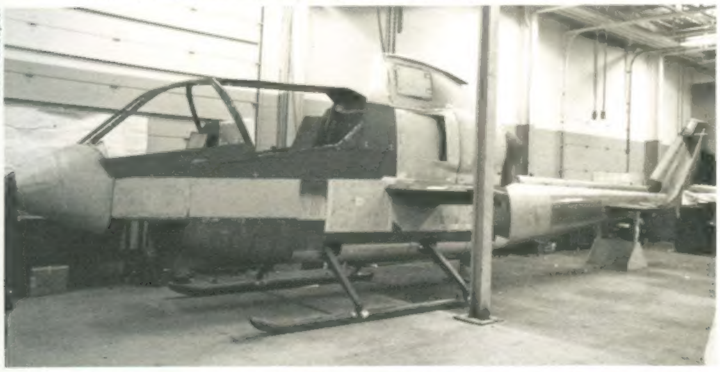
Charlie Siebel collection

Dick Ten Eyke's original March 1965 drawing depicting the first Model 209 study. Similarity to the first "Cobras" is striking. Noteworthy, however, is extended ventral, which found its way only onto the prototype and Model 309.

Bell Helicopter

An early AH-1G study calling for wingtip-mounted landing gear that when retracted, almost doubled the effective wingspan. Higher forward speeds, due to off-loading of the main rotor were thought possible; but no hardware reached the flight test stage.

Bell Helicopter



The Model 209 prototype, N-209J, under construction at Bell during the fall of 1965. The final design, by this time, essentially had been determined, though the extended ventral fin remained. Noteworthy is retractable skid landing gear.

Bell Helicopter

The prototype Model 209, civil registered N-209J, while undergoing flight trials at Bell during early 1966. The tan and brown camouflage was to be relatively short-lived as standard Army camouflage, by this date, already had become olive drab.

tion created by forces from the aircraft's collective boost cylinder. Bell had alleviated the problem during the first month of flying by adding 200 lbs. of lead to each stub wing tip. After completion of each demonstration flight, the lead weights were removed to continue the flight test program the next day. The vibration problem was corrected by installing a reverse collective system. The collective linkage which was hooked into leading edge of the rotor blades was changed to input the trailing edge of the blades instead, and a bell crank was added between the collective control and the boost system to the rotor due to the need to then reverse the direction of collective input. This solved the vibration problem and represented the only significant engineering change needed. The aircraft flew with the reversed collective linkage for the first time on October 19; and six days later, on October 25, 1965, the Model 209 set a new official world sustained speed record (in its weight class) of 200 mph in level flight (the previous record of 180.1 mph was set by a Bell UH-1D *Huey* during 1964).

On November 8, 1965 the Model 209 demonstrator arrived by truck at Edwards AFB for Army evaluation. Extensive testing by the Army Aviation Test Activity began on November 13 and continued through December 1. Subsequent testing was conducted at Fort Sill, Oklahoma, where on January 16, 1966 the turret gun was fired for the first time. Finally, on Friday, March 11, 1966 the Army announced it had selected the Bell entry as the winner in the fly-off competition and intended to immediately order the gunship into production. On April 4, 1966 the Army awarded Bell a contract for two pre-production aircraft and followed up on April 13 with an order for the first 110 production aircraft plus long lead-time spares worth $20.5 million. Subsequent contracts raised the total order for AH-1Gs to 838 by October 1968. On January 30, 1970 an additional 170 gunships were requested, followed by a further order for 70 during mid-1971. By the time the Army accepted its last "G" Model (Ser. No. 71-21052) during February 1973, Bell had delivered 1,126 *Cobras* for both the Army and Marine Corps under U.S. Army contracts.

The AH-1G foundation for success had been laid by the N209J concept demonstrator. So classic was the original airframe design that Bell was able to move from prototype to production aircraft with only minor adjustments (slightly redesigned and strengthened stub wings and a fixed instead of retractable landing gear). In fact, the design proved to be so good that during the G's six-year production run (1967-1973) only two significant changes were required: the original TAT-102A minigun turret was replaced with the improved M-28 (TAT-141) dual weapons turret, and the aircraft's tailboom was modified by moving the tail rotor from the left to the right side of the vertical fin in order to improve the helicopter's directional control characteristics.[3]

On June 4, 1967, N209J made its debut at the Paris Air Show and proved to be an instant hit with the crowd. Thereafter, the aircraft spent the next two months being demonstrated to military and civilian officials throughout Europe. Following its return to the U.S., the original *Cobra* embarked on an eighteen-month tour of major U.S. military installations and traveled north of the border to demonstrate its military prowess in Canada. Returning to Ft. Worth during March 1969, the aircraft became actively involved in a variety of company flight test programs until it finally was deactivated during February 1971. During its six years of demonstration, evaluation and testing, N209J flew 1090 hours, carried hundreds of people—including general officers and heads of state—and was seen in ten foreign countries. On November 11, 1972, N209J was presented to the U.S. Army's General George S. Patton Museum, Fort Knox, Kentucky where it now resides on permanent display.

Weight and Performance
Model 209 (N209J) Demonstrator

For most of its six-year service life, the following weights and performance figures pertained.

Weight	
Empty Weight	5,445 lb.
Crew	400 lb.
Ammunition (Internal)	520 lb.
Fuel	1,600 lb.
Wing Ordnance	2,200 lb.
Maximum Gross Weight	9,500 lb.
Performance	
V Cruise	168 kt.
V Dive	190 kt.
Range	250+ miles

[3] The only other noticeable change was minor. The *Cobra's* original nose-mounted dual landing lights were replaced with a single lamp that retracted into a recessed area underneath the nose.

AH-1G *Cobra*

Following the award of contracts during April 1966, Bell immediately began construction of the two pre-production *Cobras*. The ships were to be manufactured on a top priority basis, with actual construction to be carried out in the Experimental Area where N209J was built. The remaining aircraft were to be manufactured through normal production procedures in the company's general production area (as it turned out the third aircraft, Ser. No. 66-15248, also was built in the Experimental Department using soft tooling techniques). Because production drawings were not yet available, the pre-production ships (66-15246 and 66-15247) were to conform to the experimental configuration of the Model 209 demonstrator. However, necessary modifications toward production configuration were incorporated to render the aircraft suitable for various aerodynamic, armament, powerplant, and structural qualification testing.

The first pre-production aircraft (66-15246) was rolled out during early October 1966. It had four noticeable exterior changes marking the transition from the original N209J concept design: 1) the ship was fitted with larger and stronger stub wings to accommodate the Army's stated armament needs, 2) an increased diameter TAT-102A turret was added to make its configuration compatible with the new M-28 dual weapons turret then under development for future retrofit, 3) the somewhat squat and angular retractable landing gear had been replaced by a curved and streamlined fixed skid type gear, and 4) fixed rather than retractable pilot and gunner cockpit access steps had been provided.

The first pre-production machine made its one hour maiden flight on October 15, 1966 under the expert piloting of Bell's Gene Colvin. This aircraft subsequently was used to qualify the *Cobra's* armament system at Fort Hood, Texas during February 1967. The two-phase airworthiness testing centered around the jettisoning of rocket pods and other wing stores as well as firing the aircraft's weapons, measuring both the efficiency of the weapons and the effect of firing on the helicopter. The second pre-production AH-1G (66-15247) flew for the first time on March 10, 1967. At the controls for the eighteen minute flight was Bell test pilot Turpin Gerald. This aircraft primarily was used to fly and qualify the Stability Control Augmentation System (SCAS). It also was used in the initial training of U.S. Army *Cobra* NET (New Equip-

Bell Helicopter

Initial Model 209 flight test trials were conducted with the extended ventral in place and with the aircraft wearing flat, olive drab paint. The ventral was removed when it was determined that directional stability was sufficient without it.

Bell Helicopter

The Model 209 prototype, shown during an early test flight near Ft. Worth, Texas, was to be the only member of the "Cobra" family to be equipped with retractable skids. The aesthetics of the "Cobra" are suitably accentuated in this view.

Bell Helicopter

The Model 209 prototype is shown with its armament complement. By later "Cobra" standards, this was a thin selection, but for its day, it was quite noteworthy. Rocket pods, rockets, rotary cannon, a grenade launcher, grenades, and shells are visible.

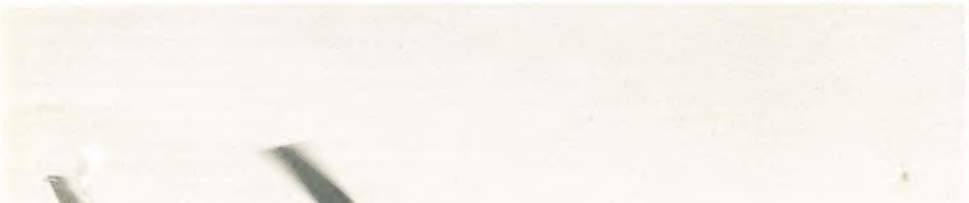
Bell Helicopter

The prototype Model 209, with its civil registration visible on its fuselage undersurface, banks away from the third AH-1G, 66-15246, during a test hop out of Bell's Ft. Worth facility. The AH-1G mounts a gun pod and rocket pod on its left pylon.

ment Training) Team pilots prior to the delivery of production AH-1Gs.

By the end of May the first two *Cobras* built to production standards (66-15248/49) had rolled off the assembly line. Initial deliveries began during June 1967, when the second production ship (66-15249) actually was turned over to the Army. Within two months the new gunships were on their way to Southeast Asia with Lt. Col. Paul Anderson's *Cobra* NET Team. On August 29, 1967, approximately 50 hand-picked, combat-wise pilots and mechanics, several civilian specialists from Bell and Emerson Electric, six AH-1Gs, and certain of the composite, electrical-hydraulic and armament system maintenance trainers were airlifted from Ft. Worth to Bien Hoa Air Base near Saigon. The team was placed under the supervision of the 1st Aviation Brigade, and its initial training of in-country Army personnel began on September 18 with pilot transition courses and maintenance instruction.

For the Vietnam gunship pilot who was used to the modified UH-1B/Cs, the AH-1G was like a dream come true. The ship's primary armament consisted of the TAT-102A turret manufactured by the Emerson Electric Manufacturing Company of St. Louis, Missouri, and featured the single electrically-driven 7.62 mm General Electric M-134 minigun. Located below the nose of the aircraft, the hydraulically-driven turret provided the *Cobra* gunner with the true sense of weapon direction. This so-called "fire hose" feel allowed for maximum target acquisition without the need for exotic and complex fire control systems. In addition, the turret location provided an "automatic" elevation compensation. With the turret located below the gunner's sight line and with a slight convergence between the sight line and the gun bore sight line, the 7.62 mm round actually crossed the gunner's line of sight twice; and therefore, retained a strike capability along the line of sight over the projectile's entire 800 meter range.



Bell Helicopter

The third AH-1G, 66-15246, specially marked for armament trials, is seen firing a salvo of 2.75" air-to-ground rockets from a pod mounted on its right pylon. A documentation camera can be seen suspended from a special cradle attached to the aft tail boom.

The gunner could direct the turret through 230° of azimuth, 21° of elevation and 50° of depression. Velocity jump compensation automatically computed the lead angle with respect to the relative motion of aircraft and target. Fire control was accomplished by the use of a hand-held, floor-mounted, pantograph sight slaved to the gun turret. Gun triggers and turret activation switches were housed neatly in the hand grips located on each side of the sight similar to the arrangement employed earlier on the Model 207. Additionally, both crew members could fire the turret when it was in stowed position (the turret automatically returned to the forward stowed position whenever the gunner released his grip on the slewing switch). Two rates of fire were provided for the gunner: 1,300 and 4,000 spm. The lower rate was designed for searching or registry fire, while the higher rate was used to fire for effect. Rate of fire was controlled by two different detents incorporated into the gunner's trigger.

The Army accepted the TAT-102A as an "interim" turret only while Emerson developed the dual weapons M28A1 automatic turret. Introduced on later production AH-1Gs, the new turret could accommodate two weapons simultaneously. The G.E. GAU-2 B/A (7.62 mm) minigun and the M-129 (40 mm) grenade launcher could be installed together or as a pair of similar weapons. Each minigun was supplied with 4,000 rounds of ammunition and could fire 2,000 or 4,000 spm in six-second bursts. The M-129 grenade launcher was provided with 231 rounds and could fire at a rate of 450 spm. Weapon selection could be made or both weapons of a kind could be fired simultaneously.

The compact M-28 turret, only 28 in. in diameter, offered azimuth travel of 115° to either side of the fuselage with 60° depression and 25° elevation. Although the turret normally was fired by the gunner, the pilot could fly the aircraft and fire the turret from its forward (stowed) firing position. For this purpose, the pilot employed a panel-mounted fixed sight and trigger switch located on

Bell Helicopter

The fifth AH-1G, 66-15248, during a test flight out of Bell's Ft. Worth facility. Noteworthy is placement of the tail rotor on the left side of the vertical tail; directional control anomalies later were corrected by moving the rotor to the right side.

Bell Helicopter

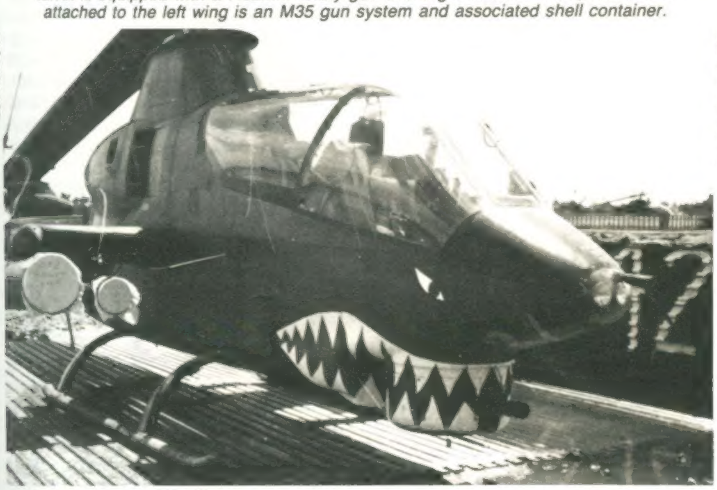
Bearing the original tan and khaki camouflage of the Model 209 demonstrator, the sixteenth AH-1G, 66-15259, is seen during a initial Vietnam deployment as part of the Army's "New Equipment Training Team" at Vung Tau during December 1967.

Bell Helicopter

With rotor turning, an AH-1G is field-reloaded in Vietnam with 2.75" rockets. The nose turret is equipped with a 7.62mm rotary gun and a grenade launcher, and visible attached to the left wing is an M35 gun system and associated shell container.

U.S. Army

AH-1G, 67-15610, in-country in Vietnam, is seen after having had its tail rotor modified and moved from the left to the right side of the vertical tail. This aircraft is believed to have been assigned to the 361st AVN Company.



Bell Helicopter

1st Cavalry AH-1G, 66-15342, in-country in Vietnam. Rocket pods have been covered for temporary protection from the harsh semi-tropical environment. 7th Sqdn. patch art is barely visible directly under nose, above gun turret.

Aerofax, Inc. collection

AH-1G, 70-16300, landing at Hopsten AB, Germany on September 29, 1973. It is equipped with an M35 gun system consisting of a 20mm rotary cannon and associated ammunition magazine. The cannon is unfaired and suspended from the left stub-wing.

Jay Miller/Aerofax, Inc.

Unusual camouflage on unidentified AH-1G during transient stopover at Bergstrom AFB, Texas. Camouflage pattern, in flat paints, consisted of sand, a dark and a medium green, and a dark gray. Serial number on vertical fin was in black.

Bell Helicopter

As an interim measure until a dedicated Marine Corps "Cobra" could be developed and produced, the service acquired some 38 AH-1Gs during 1969. These aircraft differed from their Army counterparts only in having Marine Corps markings.

the cyclic stick.

During late 1969 the Army received a half-dozen samples of the new General Electric M-35 armament subsystem for testing on the AH-1G. This consisted of a six-barrel M61 (20 mm) Vulcan cannon which usually was mounted on the left inboard wing station. Ammunition for the cannon was supplied via a fuselage-mounted ammunition box enclosed by a fuselage fairing. The system was accepted very well, and the Army subsequently ordered several hundred. Often the M-35 was used in conjunction with the M-18E1 minigun pod mounted on the right inboard wing station. It also was common in Vietnam to see the *Cobra* armed in the so-called "light scout configuration". This included twin 1,500 round M-18 pods (one on each inboard station) and seven-tube rocket pods attached to each outboard hard point.

Other wing-mounted weapons included the M-159 rocket pod containing nineteen 2.75-in. folding fin rockets. This pod could be carried on each or all of the *Cobra's* four support racks. When four M-159s were carried, the so-called "heavy Hog" was capable of unleashing 76 rockets on a single mission. Rockets could be ripple fired at a rate of six per second from each pod, and the pods normally were fired symmetrically from the two sides. The pilot normally fired wing stores utilizing a modified MK 18 adjustable rocket sight, and he could select by intervalometer any number of rocket pairs from one to nineteen (in an emergency the gunner could also fire wing stores). The aircraft also could be fitted with the seven-shot M-157 rocket pod. Like the larger pod, the M-157 could be carried on each or all four racks. Wing pods could be jettisoned by either the pilot or gunner in the event of an emergency. During the Army's qualification testing, 176 pods were jettisoned defining the extremes of flight conditions and pod configurations. These tests confirmed that the permissible envelope for jettisoning wing pods exceeded the aircraft flight envelope.

While combat experience with the UH-1 had demonstrated that aircraft's remarkable ability to sustain combat damage and still bring its crew home safely, this experience also pointed out certain critical areas where passive defensive measures were needed. Consequently, the manufacturer addressed the issue by providing the AH-1G with armor for appropriate airframe components such as the engine compressor and engine fuel control. The aircraft also was fitted with self-sealing fuel tanks foam-protected for fire retardation, hydraulic system armor, and an IR (infrared) exhaust suppression shroud installed inside the exhaust cowling.

Crew protection was enhanced through the use of bulletproof glass in the windscreen (1-1/8 in. thick), and an armor nose plate which provided additional insurance for the gunner. Finally, both crew members were provided with the protection of lightweight steel alloy seats and sliding side panels made of NOROC armor manufactured by the Norton Company. Bell was convinced that the new gunship's vulnerability would be substantially reduced by the passive defensive measures as well as its high speed capability. Subsequent combat experience would support the manufacturer's claims.

On August 31, 1967, just two days after departing the Bell plant in Ft. Worth, NET Team commander Lt. Col. Paul Anderson and Maj. Nick Stein made the first Vietnam flight in a *Cobra* (66-15259). Four days later, on September 4, 1967, the AH-1G recorded its first "kill" of the war. During an indoctrination flight in 66-15263, Maj. Gen. George P. Seneff, Jr., commander of the 1st Aviation Brigade, and CWO J. D. Thomson, a NET Team instructor, used their rockets and minigun to destroy a sampan and four Viet Cong northeast of Can Tho City in the Mekong Delta.

Although the *Cobra* had been acclaimed from the moment Bell demonstrated it to the public, Vietnam deployment activities were virtually muffled. The Army did not release the story to the press until October 9, 1967, the day after the new gunship was used for the first time on a combat operation. On October 8, two AH-1Gs from the famed "Playboy" Platoon (1st platoon) of the 334th Armed Helicopter Company, 12th Combat Aviation Group, II Field Force, flew armed escort for ten troop-carrying UH-1s of the 118th Assault Helicopter Company. The two *Cobras* were piloted by Capt. Kenneth Rubin of Charleston, South Carolina, and WO Robert E. Bey of Pompano Beach, Florida. Their gunners were Warrant Officers John Ulsh of Mount Union, Pennsylvania, and Richard Wydur of Northport, New York. So devastating was their fire that the Viet Cong were unable to squeeze off as much as a single round at the transports. After successfully providing LZ prep fires, the *Cobras* went on to destroy four heavily-bunkered VC fortifications and sank a total of 14 sampans with deadly accurate minigun fire—an impressive showing for their first time out of the starting blocks.

Bell Helicopter officials were delighted with the news from South Vietnam, as praise for the *Cobra's* contributions during the Viet Cong *Tet* Offensive continued to pour into Ft. Worth. Among the most complimentary of military personnel was Maj. Gen. Robert Williams, who had succeeded Gen. G. P. Seneff, as CO of the 1st Aviation Brigade: "It was the first time we had seen the *Cobra* take punishment," he said, "the ships had taken a few hits before *Tet*, but now they've taken a lot of rounds. It was an amazing job of delivering fire power in some tight situations." As a finishing touch to the spring of 1968, the Ft. Worth manufacturer learned in late April that it was to be honored with the American Helicopter Society's annual Grover E. Bell Award for the "timely development of the AH-1G *HueyCobra*". Bell representatives accepted the prestigious award at the Society's 24th Annual Forum on May 10, 1968.

Marine *Cobras*

Although the Marine Corps had watched the Army's development and initial deployment of the *Cobra* with considerable interest, it made no bones about the fact that what it really wanted was a twin-engine, marinized version of the gunship. Understanding, however, that the long lead time necessary to design and test such an aircraft would significantly delay its introduction into Vietnam, the Corps decided to accept several single-engine Army variety G Models as interim gunships until the desired twin-engine AH-1J could become available. (On May 29, 1968 the Marines placed an order for its first 49 AH-1J *SeaCobras*. Bell unveiled the first such machine at Ft. Worth on October 14, 1969.) Just one month before the Army deployed its first *Cobras* to Vietnam, the Secretary of the Navy gave his approval for the Marine buy of seventy-two AH-1Gs—enough to form a squadron of 24 gunships for each of the Corps' three active air wings. After review, however, Secretary of Defense McNamara cut the Marine request back to only 38.

Built under Army contracts (c/n DAAJ01-67-C-0043/DAAJ01-68-C-0469), the first ships were accepted for the Marine Corps by the U.S. Army Bell Plant Activity during February 1969. Five of the first aircraft[4] were immediately ferried to Hunter Army Airfield at Ft. Stewart, Georgia to be used by Army instructor pilots in transitioning the first four Marines into the *Cobra*. (The Marine pilots, Majors Jimmie A. Creech, James W. Rider, Ronald J. Thrasher, and John L. "Jack" Pipa, completed the training along with other Army flyers during the spring of 1969. In typical fashion, the Marine Corps pilots graduated in class standing one through four respectively out of the class of 39 pilots.) In addition to the five aircraft used for training, two other Marine *Cobras* were set aside for further research and development studies. The remaining aircraft were rushed to Vietnam for combat evaluation as quickly as they came off the assembly line.

At about the same time the four stateside Marines were transitioning into the new gunship, three other Marine officers were at Bien Hoa undergoing a similar training process in preparation for the arrival of the first Marine *Cobras* in Vietnam. On April 10, 1969 the first four AH-1Gs did arrive in-country and were assigned to Lt. Col. Clark S. "Sandy" Morris of VMO-2 based at the Marble Mountain Air Facility located a few miles east of downtown Da Nang. Eight days later, on September 18, 1969, Maj. Donald E. P. "DEP" Miller (now a Brig. Gen.), accompanied by 1st Lt. Tommy James, had the distinction of flying the first Marine *Cobra* combat mission in South Vietnam. Miller recently reminisced about his experiences during the spring of 1969:

> "In early April 1969 our *Cobras* arrived at Marble Mountain and VMO-2 put them to work. On April 18 I managed to fly the first USMC combat mission in an AH-1G. It was a medivac escort of CH-46s which lasted 3.3 hours. It was your standard 'Mission 11' with lots of excitement, some seriously wounded Marines, and a few moments of stark terror dodging enemy gunfire. It was several missions later when I returned from an escort with a bullet hole in my *Cobra*. The AH-1G did not often get shot at because the enemy learned that it wasn't healthy to shoot at *Cobra* gunships. Our medivac CH-46s weren't as fortunate.
>
> "I flew my final combat mission in Vietnam on December 2, 1969, after having amassed several hundred hours in the great single-engine escort platform. The *Cobra* truly was a lifesaver for Marines on the ground and for both CH-46s and CH-53s who supported our ground brothers. I honestly don't know what the Corps would have done without its services."

Cobra deliveries continued and by June 1969 ten aircraft had reached the end of the pipeline at Da Nang. The three-month long evaluation went very well, and the Marines of VMO-2 were delighted with the *Cobra's* sparkling performance. Former UH-1 pilots were particularly impressed with the AH-1G's exceptional armament system. While the modified UH-1E gunships had done an admirable job since their introduction four years earlier, the new *Cobra* provided greater speed, firepower and flexibility. Overall the AH-1G proved far superior to the UH-1E in the delivery of accurate, close-in fire support during vertical assault operations. Finally, the new gunships were able to free the UH-1Es to perform the light helicopter mission for which they originally were intended.

Although the first Marine units began withdrawing from Vietnam during August 1969, the Marine AH-1Gs remained until the end (several AH-1Gs were used during LAMSON 719—the assault into Laos in early 1971). On May 26, 1971 the Corps' last squadron operating AH-1Gs (HML-167) ceased combat operations and redeployed to Marine Corps Air Facility, New River, North Carolina. During the two years that the AH-1G served in Vietnam, it proved beyond a doubt that it was a vital member of the Marine air-ground combat team.

Model 309 *KingCobra*

On July 25, 1969 the President of the United States announced a new policy aimed at bringing peace to Vietnam. The so-called "Nixon Doctrine" marked the start of an effort to gradually disengage U.S. troops from the war, while strengthening the South Vietnamese Armed Forces and improving the social and political climate in the war-torn republic. By January 1972, U.S. combat strength in South Vietnam had been reduced to less than 70,000.

As its aviation units started standing down, the Army began focusing its attention on the role of the attack helicopter on the mid-intensity battlefield. Particular attention was given to exploring tactics and technology necessary to cope with sophisticated enemy air defenses and defeating enemy armored vehicles. The huge inventory of Warsaw pact tanks made it imperative that an attack helicopter tank-killing capability be made available as quickly as possible. Although the proposed AH-56A was to have anti-armor capability, by the start of 1971 all concerned realized the aircraft's future might be in jeopardy. The solution: combine two proven weapon systems—the TOW anti-armor missile and the AH-1 *Cobra*.

Fortunately, the Hughes BGM-71A TOW (Tube-launched, Optically-sighted, Wire-guided) anti-armor missile already was a part of the Army's inventory, having been widely deployed in the ground-based mode during the early 1960s. The first airborne launches of the TOW missile were conducted during October 1966 using Bell UH-1Bs as launching platforms. The UH-1B/XM26 TOW combination testing, carried out in connection with the on-going AH-56A program, concluded in mid-1968 after having launched a total of 62 missiles. (An additional 110 TOW firings were made from AH-56A prototypes between July 1967 and August 1972.) Placed in storage following the cancellation of further *Cheyenne* production during May 1969, the two UH-1B/TOW aircraft were re-activated for additional testing in both the U.S. and Europe during the summer of 1971.

Meanwhile, Bell Helicopter already had begun to address the military's need for an improved tank-killing AH-1. Following a policy of providing a "fly-before-buy" prototype or demonstrator for use in evaluating its most significant product improvements, Bell decided to build two flying prototypes of its proposed Model 309 *KingCobra*: a single-engine version based on the AH-1G and a twin-engine example derived from the USMC AH-1J *SeaCobra*. William F. Gurley, Bell *KingCobra* Program Manager, and Bart Kelley, Vice President of Engineering, assembled their team of project engineers and directed the gifted Joe Tilley to begin the preliminary design work. Construction of the two company-sponsored aircraft began in earnest during January 1971 and this effort further was extended to a completely integrated weapons system aimed at day-night anti-armor missions with a high degree of survivability in the European-type mid-intensity battle setting. Bell's initiative was aimed at saving valuable lead time and providing the military with a relatively low-cost anti-armor machine. Bell estimated

[4] These aircraft were 68-15037, 038, 039, 045, and 046. Although the USMC AH-1Gs were allocated a block of BuAer numbers (157204 through 157241), all 38 machines retained their Army serial numbers. The remaining 33 aircraft were: 67-15850; 68-1072, 073, 079, 080, 085, 104, 105, 112, 113, 134, 140, 165, 170, 190, 194, 198, 203, 213; 68-17023, 027, 041, 045, 049, 062, 066, 070, 082, 086, 090, 101, 105, and 1085.

that the new *KingCobra* could be supplied to the Army at an average fly-away cost of $1.5 million per copy in FY 1973 dollars.

Both versions of the Model 309 had a designed gross weight of 14,000 lbs.—some 40% heavier than the previous AH-1G and AH-1J. To accommodate loads associated with operation at higher weights and levels of power, the basic AH-1 fuselage was stretched from 44 ft. 5 in. to 48 ft. 9 in. and stiffened and strengthened. The new gunship also was fitted with an uprated dynamic system, including an improved transmission and associated tail rotor system rated at 2,000 shp, and a larger 48 ft. main rotor. (The rotor, transmission and drive train had been tested extensively on Bell's Model 211 *Huey Tug* field artillery prime mover introduced during 1968.) The new main rotor featured wide-cord blades and swept tips to reduce noise and improve high speed performance. Other modifications included a tailboom extension to compensate for the increased rotor diameter, a larger 10 ft. 2 in. tail rotor, a ventral fin for increased longitudinal stability, Teflon-faced rotor hub bearings which required no lubrication, and a re-designed nose to accommodate a stabilized multi-sensor sight system.

The twin-engine demonstrator (Bell airframe number 2503) was fitted with the AH-1J's 1,800 shp Pratt & Whitney (United Aircraft of Canada) T400-CP-400 coupled free-turbine turboshaft powerplant (military version of the UAC PT6T-3 *Turbo Twin Pac*). The *Twin Pac* consisted of two PT6 turboshaft engines mounted together and each driving into a combining gearbox with a single output shaft. In the event of an engine failure, the remaining engine could continue to drive the aircraft's rotors through the combining gearbox, and had sufficient power to permit safe operation to a suitable landing area. Bell proposed a growth program for the *Twin Pac* that would increase the rating to 1,970 shp, with further potential growth to 2,400 shp. The single-engine version (a/c number 2504) was powered by the Avco-Lycoming T55-L7C turboshaft engine (also previously used in Bell's Model 211 *Huey Tug*) rated at 2,850 shp to provide 2,000 shp at 4,000 ft. on a 90° day.

The Bell design and engineering team incorporated a variety of sophisticated systems and subsystems to ensure that the *KingCobra* would be capable of carrying out the anti-armor mission under the most adverse conditions of weather, terrain and enemy threat. Ten prominent suppliers of components and subsystems contributed hardware and engineering effort to the program to successfully integrate and demonstrate the total advanced armed helicopter system. The first control subsystem installed in the *KingCobra* provided a full fire control solution, utilizing an integrated navigation and fire control computer manufactured by Litton Guidance and Control Systems. It consisted of a stabilized multi-sensor sight with 3x and 12x day optics and 2x and 6x night optics, neodymium laser, a pilot's head-up display (HUD) supplied by the General Electric Aircraft & Equipment Division, and a Sperry Rand/Univac helmet sighting system. The subsystem also included TOW missile guidance and electronic components. Additionally, Bell engineers provided the aircraft with SCAS and an Attitude Retention Unit (ARU).

The *KingCobra* also was fitted with a sophisticated night vision and target acquisition subsystem consisting of two independent night vision sensors: A Texas Instruments FL-33 forward-looking infrared (FLIR) was located in the stabilized sight, and imagery from this sensor was displayed through the sight to the gunner and through the HUD unit to the pilot. Secondly, a Dalmo Victor 40/25 low light level television (LLLTV) sensor was installed for use by the pilot (through the HUD unit) as both a navigation and terrain avoidance aid when the copilot/gunner was tracking targets with the sight-mounted FLIR. Other navigation equipment included a Litton LN-30 inertial navigation system to permit accurate navigation to pre-selected destinations without ground navigational aids. This advanced system allowed circuitous routing at nap-of-the-earth altitudes without loss of bearing or distance to the destination. To compliment this system, a Honeywell-built APN-198 radar altimeter with low-altitude warning capability was provided.

Special attention was paid to the gunship's armament and survivability features. The primary armament subsystem was, of course, the TOW anti-tank missile. The short span (9 ft. 4 in.) stub wings of the AH-1G were modified and lengthened to 13 ft. on the *KingCobra* and four wing pylons rated at 750 lb. each were provided to accommodate up to 16 TOW missiles, or fewer missiles when used in combination with other wing store armaments. The aircraft's General Electric turret contained a three-barrel 20mm Gatling gun (similar to that used on the U.S. Marine Corps AH-1J) with linkless drum storage for up to 1,345 rounds of 20mm ammunition. The turret also was designed to accept a three-barrel 30mm Gatling gun and up to 1,000 rounds of ammunition. Survivability features included crash resistant fuel cells, aircraft and aircrew protection against .50 caliber rounds, and an ITEK, Applied Technology lightweight aerial radar warning system (LAWS) to alert the pilot if the aircraft were detected by hostile radar and to provide distance to the threat for use in tactical planning and evasion. Provisions also were made for add-on electronic and infrared countermeasure equipment and missile subsystems for stand-off suppression and destruction of enemy air defense systems.

On September 10, 1971, the prototype twin-engine *Cobra* (registered N309J) of Bell's third-generation attack helicopter lifted off from Bell's Ft. Worth flight test facility on its 30 minute maiden flight. At the controls was Bell test pilot Gene Colvin. Thirteen days later, on September 23, 1971, the company privately unveiled both versions of the Model 309 to a distinguished group of military observers. On September 28 Bell followed up the military presentation with a formal public announcement of its intent to develop the advanced armed helicopter. Flight testing of the twin-engine aircraft continued throughout the remainder of the year under the able direction of Chief Flight Test Engineer William Jennings. The prototype continued to perform well, demonstrating its ability to exceed 200 knots (230 mph) in a dive and easily perform 3g+ maneuvers at cruising speed.

Meanwhile, during January 1972, Colvin also flew the single-engine demonstrator on its maiden flight. The program suffered a setback, however, when this aircraft was badly damaged in an accident eight miles south of the Arlington, Texas airport on April 11, 1972. A subsequent investigation disclosed a nut on the collective boost cylinder had worked loose causing the cylinder to separate in flight. The helicopter immediately assumed an uncontrolled low-pitch attitude; impacted the ground; and rolled over when the main rotor made contact with ground. Fortunately, pilot Bob Walker and his cockpit companion, flight test engineer Ron Mageuson, escaped without injury.

As the summer of 1972 approached, industry speculation increased that the Army was about to shelve the AH-56A *Cheyenne* in favor of a smaller, slower and less complex attack helicopter. But what the Army wanted was more than a singular purpose aerial fire support machine—it sought a truly integrated helicopter weapons system with primary emphasis placed on the anti-armor mission. Fully cognizant that cancellation of the *Cheyenne* would create a void in Army procurement plans and mission planning objectives, Bell management moved quickly to ensure that the new Model 309 would be ready to fill the anticipated Army need. Unsure about the possibility of hidden structural damage to the badly bent single-engine *Cobra* testbed, Bell's Chief Experimental Projects Engineer, Charlie Seibel, recommended the twin-engine example (A/C 2503) be temporarily converted to a single-engine configuration in order to have a suitable (single-engine) demonstration prototype available for Army evaluation. The conversion was carried out without delay.

When the Army finally announced its decision to terminate the AH-56A on August 9, 1972, both Bell and Sikorsky rushed to meet the service's "unofficial" requirement for a less sophisticated attack helicopter. Sikorsky submitted its Model S-67 while Bell, of course, offered the single-engine Model 309. Four Army test pilots were able to fly approximately 60 flight test hours in the *KingCobra* during the autumn of 1972. During the Army's submission—both at the Ft. Worth flight test facility and at Alamosa, Colorado—its test pilots were able to verify Bell's claims on performance, reliability, systems integration, and overall airworthiness. Already, however, the winds of change were beginning to blow again.

During November 1972 the U.S. Army's Advanced Attack Helicopter (AAH) Task Force issued a new set of requirements. Convinced that neither the *KingCobra* nor the Model S-67 could meet its latest specifications, the Army sought new proposals industry-wide. Bell design engineers returned to the drawing boards and produced the Bell Model 409. (It should be noted that Sikorsky continued its developmental work on the proffered Model S-67 which eventually led to a 1976 Army contract for an assault helicopter based on that design. The resultant machine was the highly successful UH-60A *Black Hawk* first delivered during 1978.) On June 22, 1973 Bell was awarded an engineering development contract and notified that its Model 409 (officially designated the AH-63 by the Army) was to be evaluated in a competitive fly-off against the Hughes-designed Model 77 (AH-64).

Although the *KingCobra* prototype was never put into production, the experience of putting together the integrated avionics, armament and navigation systems was of great value to Bell. This experience was applied in the development of a new full solution digital fire control system which has demonstrated extremely high accuracy gunfire and vastly improved rocket fire capability on the Army's latest AH-1F *Cobra*. The Model 309 laboratory integration experience allowed Bell Helicopter Textron to meet an extremely tight (13-month) schedule from the new gunship's date of first contract to the start of Yuma Proving Ground armament critical issues demonstration tests in the AH-1F prototype. These tests proved extremely successful, surpassing Army accuracy requirements by a factor of three. Likewise, the twin-engine example of the *KingCobra* underwent a Navy Preliminary Evaluation during March 1974 involving more than 30 flight hours. This NPE led to an initial procurement contract for 57 U.S. Marine Corps AH-1T aircraft—essentially the twin-engine version of the *KingCobra*.

Army Single-Engine Variants: AH-1Q / AH-1S / AH-1P / AH-1E / AH-1F

AH-1Q / AH-1S

The autumn of 1972 marked a significant turning point in the Army's quest for an advanced attack helicopter. After abandoning the AH-56A program during August and rejecting the S-67 and Model 309 as unsuitable replacements, the Army elected to seek an all new design under the auspices of its newly-formed Advanced Attack Helicopter (AAH) Task Force. But once the Task Force issued its revised RFP during November 1972, the Army found itself caught up in what seemed like a case of *deja vu*: the new AAH machine probably would not be available for deployment until sometime after 1980, yet there was an urgent need for an attack helicopter with anti-armor capability.

Faced with the Warsaw Pact's growing inventory of tanks, a compromise plan was settled on whereby the Army would (1) modify its current fleet of AH-1Gs by adding the TOW anti-armor missile system, (2) procure additional new AH-1 aircraft to fill in for the AAH in the meantime, and (3) supplement the existing *Cobras* to pro-

Weights and Performance
Model 309 (Single-Engine) *KingCobra*

Weight	Clean	8 TOW	16 TOW	76 FFAR
Empty Weight	8,926 lb.	8,926 lb	8,926 lb	8,926 lb.
Crew	400 lb.	400 lb	400 lb	400 lb.
Fuel	2,300 lb.	2,300 lb.	2,300 lb	1,855 lb.
20mm Ammo. (1,345 rds.)	753 lb.	753 lb	753 lb	753 lb.
TOW Launcher & Missiles	--	652 lb.	1,304 lb	--
Rockets & Launchers	--	--	--	2,700 lb.
Useful Load	3,675 lb.	4,399 lb	5,123 lb.	6,074 lb.
Gross Weight	12,601 lb.	13,325 lb	14,049 lb.	15,000 lb. (Max Alt GW)

Performance:

Gross weight for OGE hover, 4,000 ft. 95° F	14,000 lb
V_h Clean	180 kt
V_{ne}	200 kt

Endurance — 3+ hours with 2,300 lb. of fuel

Bell Helicopter

The Marine Corps found the AH-1G modestly suitable, but deficient in power and payload. Additionally, because of the Marine Corps mission, twin-engine reliability was considered mandatory. AH-1G, 68-15134, was the sixteenth Marine AH-1G.

Bell Helicopter

AH-1G, 70-16055, almost certainly was the first "Cobra" to be converted to AH-1Q "TOW Cobra" standard. Four TOW missile tubes are visible suspended from the right stub wing during initial hover tests at Bell's Arlington, Texas flight test facility.

Bell Helicopter

The two-wire-guided TOW is an effective anti-tank and anti-armour weapon. Guidance is semi-automatic command to line-of-sight (SCALOS). The gunner keeps his sight aligned with the target throughout the missile's flight.

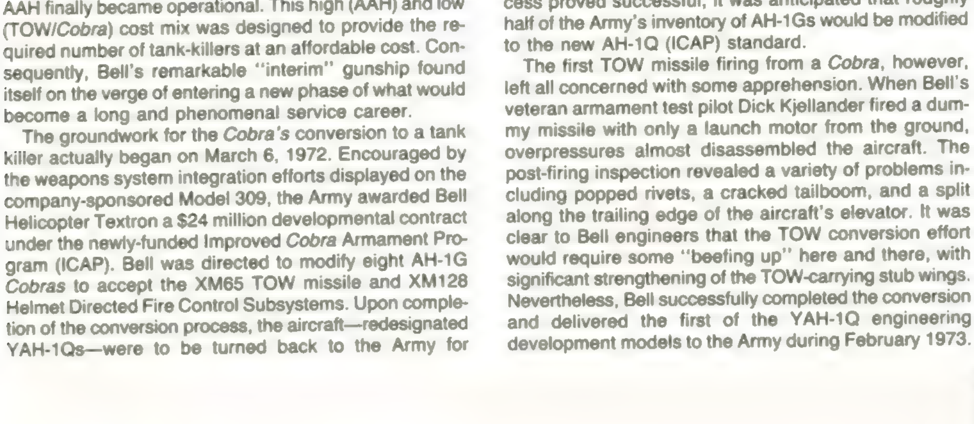
Bell Helicopter

Rarely seen YAH-1R, 70-15936, served as a testbed for the ICAM (Improved "Cobra" Agility And Maneuverability) program, and later, as a testbed for the APE (Army Preliminary Evaluation) program exploring the attributes of composite blades.

vide the needed number of attack helicopters when the AAH finally became operational. This high (AAH) and low (TOW/*Cobra*) cost mix was designed to provide the required number of tank-killers at an affordable cost. Consequently, Bell's remarkable "interim" gunship found itself on the verge of entering a new phase of what would become a long and phenomenal service career.

The groundwork for the *Cobra's* conversion to a tank killer actually began on March 6, 1972. Encouraged by the weapons system integration efforts displayed on the company-sponsored Model 309, the Army awarded Bell Helicopter Textron a $24 million developmental contract under the newly-funded Improved *Cobra* Armament Program (ICAP). Bell was directed to modify eight AH-1G *Cobras* to accept the XM65 TOW missile and XM128 Helmet Directed Fire Control Subsystems. Upon completion of the conversion process, the aircraft—redesignated YAH-1Qs—were to be turned back to the Army for qualification and service testing. If the conversion process proved successful, it was anticipated that roughly half of the Army's inventory of AH-1Gs would be modified to the new AH-1Q (ICAP) standard.

The first TOW missile firing from a *Cobra*, however, left all concerned with some apprehension. When Bell's veteran armament test pilot Dick Kjellander fired a dummy missile with only a launch motor from the ground, overpressures almost disassembled the aircraft. The post-firing inspection revealed a variety of problems including popped rivets, a cracked tailboom, and a split along the trailing edge of the aircraft's elevator. It was clear to Bell engineers that the TOW conversion effort would require some "beefing up" here and there, with significant strengthening of the TOW-carrying stub wings. Nevertheless, Bell successfully completed the conversion and delivered the first of the YAH-1Q engineering development models to the Army during February 1973.



Bell Helicopter

AH-1Q (originally built as an AH-1G), 70-16019, in special da-glo test markings for TOW program, during test flight near Ft. Worth, Texas. Small test boom for yaw alignment verification is visible protruding from nose, and electrical harness can be seen on top of right stub wing. Gun turret is equipped with 7.62mm cannon and grenade launcher.

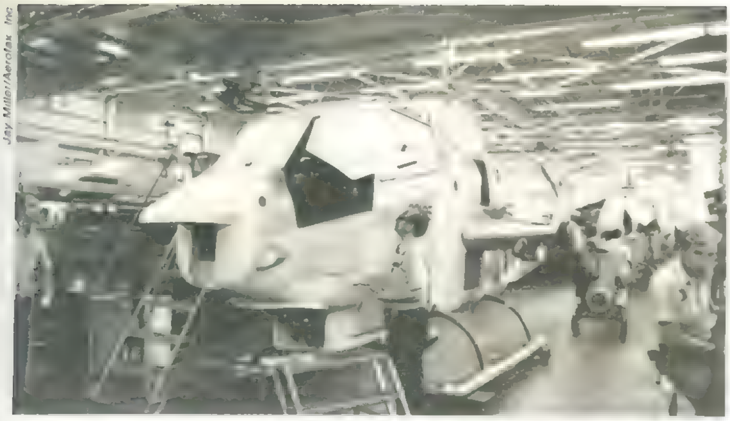
The remaining seven machines were completed during the period April 1973 through July 1974.

The conversion of the AH-1G to "Q" standards gave the Army an attack helicopter that could play a significant role in the mid-intensity, high threat battlefield environment. The modified helicopter had the ability to remain hidden, hovering near ground level behind a concealed position, until an enemy target was spotted. It then could rise up, fire its lethal TOW missile, guide it to the target, and then vanish from sight. In addition to its eight TOW missiles, the YAH-1Q could also carry 2.75-in. high explosive rockets, and retained the G Model's chin turret containing a 7.62 mm machine gun and a 40 mm grenade launcher.

Because the anti-armor capability was categorized as an "urgent requirement", concurrent development, testing, and production were necessary to meet the schedules for deployment. Therefore, prior to final system qualification, the Army awarded Bell a production contract (c/n DAAJ01-74-C-0122) on January 31, 1974 to convert 101 AH-1Gs (Bell airframe numbers 19001-19101) to AH-1Qs. This allowed delivery of the first production AH-1Q TOW/*Cobra* only 39 months after the developmental contract award. Total amount of the prime contract was $59.2 million, with a major portion earmarked for sub-contractors Hughes Aircraft Company (TOW missile system) and Univac Division of Sperry Rand (helmet sight subsystem). The contract specified the installation of eight lightweight TOW missile containers (disposed as two-round pods on each of the outboard underwing pylons) and assorted components to include a 2x/13x telescopic gyro-stabilized gunner sight, guidance and control equipment, and cockpit controls and displays for the pilot and gunner. The pilot's helmet sight subsystem featured a laser rangefinder, gyroscope, wind sensor, computer, and pilot sight to display the TOW missile's projected impact point at any given range. The first engineering development model test of the TOW system was conducted in July 1974, and the Army completed its check test of the system the following month.

The January 1974 contract also provided the Army with options to modify additional AH-1G to Q/TOW configuration, and on December 16, 1974 the Army exercised its options to convert an additional 189 AH-1Gs (A/C 19102-19290). The terms of the additional $54.2 million agreement called for Bell to convert 11 of the AH-1Gs at the company's Hurst, Texas plant and modify the re-

Jay Miller/Aerofax, Inc



AH-1S production line at Bell's Ft. Worth, Texas plant during 1980. Aircraft were virtually complete before being rolled into the paint shop. This aircraft, Bell No. 22185, lacks nose TOW system turret assembly and gun turret.

Bell Helicopter

An early test AH-1S, with an M159 19 tube 2.75" FFAR launcher, painted bright orange, attached to its left stub-wing. An AN/ALQ-144 infrared jammer is visible mounted atop the engine aft fairing, ahead of the exhaust.

Bell Helicopter

Early production AH-1S, lacking tail boom aft fairing and gun turret housing, during test flight at Bell's Arlington, Texas flight test facility. Aircraft is equipped with camera mount on left skid forward tip, and 2.75" FFAR pods on right stub-wing.

Bell Helicopter

"Modernized" AH-1Ss (shown) have an extended, aft-directed exhaust nozzle, the addition of an AN/AAS-32 laser tracker housing on the front end of the rotor pylon fairing, and a special dorsal mount for the AN/ALQ-144 infrared jammer.

maining 279 aircraft to ICAP standards at Bell's Armarillo, Texas facility. Hence, the total G to Q conversion effort was planned for 290 aircraft with the last ship scheduled for completion during July 1977. The Army anticipated, and subsequent testing of the YAH-1Qs confirmed, that the added weight (492 lbs.) of the TOW missile subystem degraded the ability of the modified Q aircraft to perform in a mid-intensity environment. To overcome the AH-1Q's less than desirable payload and performance capability in nap-of-the-earth (NOE) tactical flight maneuvers, the Army proposed a Product Improvement Program (PIP) to develop and qualify an uprated engine and drive train (main transmission and 42° and 90° gearboxes). These improvements, along with structural strengthening of the airframe to accommodate the increased power, allowed the aircraft's maximum gross weight to be increased to 10,000 lbs. Known as the Improved *Cobra* Agility and Maneuverability (ICAM) program, initial plans called for a two-ship development/qualification program consisting of one AH-1G aircraft upgraded to ICAM configuration and designated YAH-IR (sans the TOW subsystem); and one YAH-1Q (with TOW) updated to the ICAM configuration and designated YAH-1S.

In order to achieve the desired performance from the developmental machines, it was necessary to uprate the AH-1G/Q powerplant by 400 shp. Therefore, on April 5, 1974, a contract was awarded to AVCO-Lycoming to modify the *Cobra's* T53-L-13 engine from its existing 1,400 shp to the required 1,800 shp. The uprated engine, designated the T53-L-703, achieved its power growth over the T53-L-13 through increased gas producer speed and increased operating temperatures made possible by improved air cooling of the first-stage turbine. The contractor also employed new materials in the second-stage gas producer and power turbines and incorporated a T7 interstage turbine temperature sensor harness. This new device provided a more accurate indication of engine internal temperature than the T9 temperature (exhaust gas) sensed in the L-13. It was expected that the contractor could eventually modify all the required L-13s to L-703 standards at an approximate cost of $56,000 per unit; and hence, the total cost package for modification of the projected 290 AH-1G/Qs to the ICAM configuration was estimated at $30.8 million in FY 1974 dollars—or a fly-away-cost per copy of about $110,000.

On May 14, 1974 the Army awarded the developmental airframe contract to Bell. The agreement called for the contractor to modify the two previously mentioned aircraft to ICAM configuration. In addition to installing the L-703 engine, Bell was to fit the aircraft with a derivative of the 1,290 shp (1,134 continuous shp) transmission in production for the Marine Corps AH-1J/UH-1N and the commercial Model 212 helicopters. The Model 212 tail rotor and hub also were incorporated along with the push-pull tail rotor controls from the AH-1J and the required uprated gearboxes. Both aircraft had a maximum gross weight of 10,000 lbs.; however, the added weight of the TOW system installed on the YAH-1S resulted in a 500 lb. decrease in useful load (down to 3,600 lbs.) and a like amount of increase in empty weight (up to 6,400 lbs.) over the YAH-1R "slick" aircraft. Bell completed its modification of the two development machines during December 1974, and after conducting ground and flight trials both ships were turned over to the Army for qualification and testing.

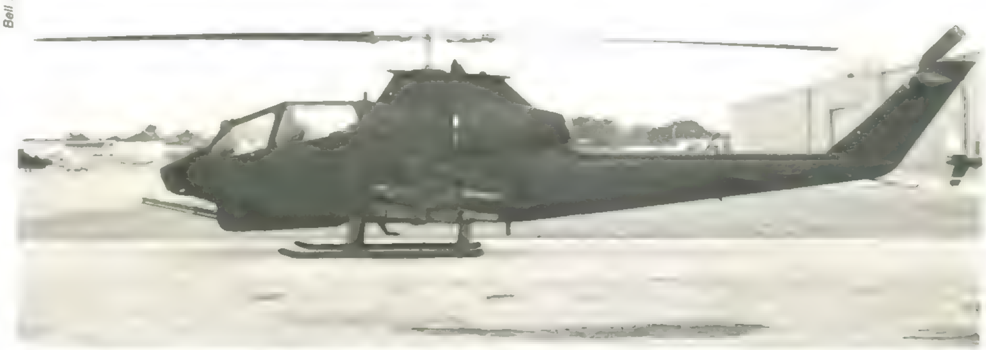
In order to meet the urgent operational needs of the Army, it was clear that the ICAM modifications would be needed on all *Cobras* as quickly as possible. When the program experienced increases in production leadtime and a deferral of funds which threatened to significantly impact delivery and mission capabilities, the Army's

Performance

	YAH-1S	YAH-1R
Armament Payload	4,000 rds. 7.62 250 rds 40mm (8) TOW Missiles	4,000 rds. 7.62 250 rds 40mm (38) 2.75 Rkts
Fuel (JP-4)	1,716 (lbs.)	1,659 (lbs.)
Continuous Cruise Speed	128 Kts	134 Kts
Endurance (10% Reserve Fuel)	2.9 Hrs.	3.0 Hrs.
Range (10% Reserve Fuel)	280 NM	290 NM
Service Ceiling	12,400 Ft.	12,200 Ft.
Hover at Take-off Weight		
• Inside Ground Effect	12,400 Ft.	12,100 Ft.
• Outside Ground Effect	4,800 Ft.	3,800 Ft.

Cobra Project Manager developed a plan to accelerate the program by using long leadtime investment to offset production leadtime along with structural provisions to facilitate retrofitting at a later date. The plan allowed for delaying a full production decision until the Office of the Secretary of Defense (OSD) approved the results of the developmental aircraft qualification program. The OSD was briefed on the plan during November 1974 and, following completion of the two developmental aircraft,

Bell Helicopter



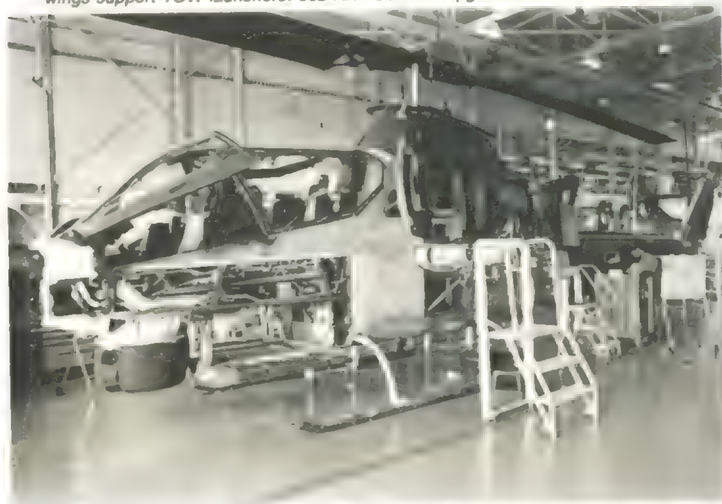
"UpGun" AH-1Ss, such as 76-22570, lacked the extended infrared suppressing exhaust nozzle, but were equipped with the 20mm M197 cannon in their Universal nose turret. Internal changes from the earlier production AH-1Ss included a 10kVA generator/alternator and an improved wing stores management system.

Jay Miller/Aerofax, Inc

An early production, first-generation AH-1S. Slightly bulged transparency side panels indicate an upgrade from the original flat plate design. Armament from the nose turret has been removed, but the stub-wings support TOW launchers and 2.75" FFAR pods.

Fred Harl

Production standard AH-1S, 76-22575, at St. Louis Lambert IAP. Original abbreviated exhaust nozzle is discernible. Cannon has been removed from nose turret, but stub-wings support TOW launchers. 662 AH-1Gs were upgraded to AH-1S standard.



Aerofax Inc collection

Most older AH-1Ss have been steadily upgraded to "Modernized" standard. Much of this upgrade work was (and continues to be) conducted at Bell's Amarillo, Texas facility. A "Modernized" AH-1S is seen in final assembly during 1987.

the plan was approved the following month. Subsequently, $7.7 million was awarded for long leadtime items for the T53-L-703 engine in late January and the power train components during March 1975.

After reviewing the results of the YAH-1R/YAH-1S qualification testing, the Army initiated a modification contract to Bell on June 30, 1975 to enable the ICAM improvements to be incorporated into the contractor's ongoing AH-1Q production contract. All AH-1G/Qs modified to ICAM standards were officially designated AH-1S (MOD) *Cobras*. The long leadtime items program approved at the beginning of 1975 helped to reduce the number of aircraft eventually to be retrofitted under the ICAM program, eased the complexity of the retrofit process, and decreased the maintenance time needed to accomplish it. Only 20 *Cobras* needed to be retrofitted at depot level, whereas a total of 72 AH-1Qs were produced with the key structural modifications to accept the improved engine and power train components. The remaining 198 of the original 290 AH-1Gs selected for Q/TOW modification were delivered as AH-1S (MOD) aircraft with the full ICAM performance improvements already installed.

Among the most important improvements to the *Cobra* was the development of a new composite fiberglass main rotor blade. On March 7, 1974 the Deputy Secretary of Defense authorized a PIP to develop a low-cost, long-life main rotor blade for the AH-1Q. The following October initial design contracts were issued to Bell, Hughes Helicopter, and Kaman Aerospace Corporation to investigate the feasibility of improving the *Cobra's* hot day hovering performance through the use of new airfoils and changes in blade performance and twist. After reviewing the proffered design studies and proposals, the Army Aviation Systems Command awarded a $4.8 million contract to Kaman on May 1, 1975 for the design, fabrication, flight test, and qualification of an Improved Main Rotor Blade (IMRB) for the AH-1Q/S. This was a unique award in that Kaman Aerospace was to manufacture a major component on an aircraft designed and produced by another contractor (this was due in part to government regulations requiring that various percentages of major production programs be subcontracted).

During early 1976 the *Cobra* Project Manager's Office was directed by the Department of Defense to shorten the development program for the IMRB in order to allow earlier modification of the TOW/*Cobra* fleet in Europe. A revised development program schedule was established and subsequently approved on April 13, 1976. A Pre-First Flight Design Review was held at Kaman's Bloomfield, Connecticut facility April 27-28, 1976, and on July 26, 1976, Kaman successfully conducted a 1.25 hour first flight of the *Cobra* IMRB on an AH-1. All flight requirements for this first flight were successfully completed, although only hover flight mode was attempted.

With a number of the objectives having been met, the IMRB test program continued with satisfactory results through the remainder of 1976. Testing showed the new blade could sustain a hit by a 23mm high explosive (HE) round and continue to operate. Survivability also was enhanced due to a reduction in noise level and radar signature, and the new blade's improved design provided an appropriate 7% increase in lift capability. With this, the requirement to hover out of ground effect (HOGE) at 4,000 ft. and 95°F (the so-called hot day performance) was achieved. Perhaps, most importantly, the new blade (designated the K-747) had an estimated service life in excess of 10,000 hrs.—a ten-fold increase over the Bell B-540 metal blade then in use. Although the new blade was estimated to cost roughly twice as much as the metal variety, the Army anticipated that the composite blade would result in an approximate savings of $29 million over a ten-year period. In addition, the field repairability features of the new blade made it a very attractive alternative to the metal blade. (It should be noted that initially the Army hoped the new blade would incorporate an electrical deicing system. However, this subsystem was "traded off" in the interest of reduced radar reflectivity. Consequently, the *Cobra*, with or without the IMRB, cannot presently be released for flight in moderate icing conditions.)

During August 1976 the Army Aviation Systems Command (AVSCOM) directed the U.S. Army Aviation Engineering Flight Activity (USAAEFA) to conduct an Army Preliminary Evaluation (APE) of the YAH-1R (70-15936) fitted with the composite blades. The objectives of the APE were to 1) determine the suitability of the aircraft incorporating the new blade for future Army testing and 2) determine the effects of the K-747 on the YAH-1R performance. Eleven flights totaling 13.0 hours (9.9 productive flight hours) were conducted by Project Pilot Maj. Jerry Guin between November 26 and December 6, 1976. The test aircraft had strengthened wings from an AH-1Q installed to allow mounting of TOW missile launchers. Aircraft configurations tested included 8-TOW (two dual-TOW launchers on each outboard wing store location) and Hog-TOW, an 8-TOW configuration with an XM200 rocket launcher (one rocket launcher on each inboard and outboard wing station). The testing showed that the YAH-1R stability and control characteristics were not significantly changed by installation of the K-747 rotor; qualitatively, the K-747 rotor was quieter than the B-540 rotor; and no deficiencies or shortcomings associated with the new blades could be found. Consequently, a low-rate initial production contract was awarded to Kaman during April 1977 for 200 of the K-747 blades. The new blades first were installed on the 149th new production AH-1S (ECAS) helicopter (78-23043) during April 1979 and fielded to the 3rd Armored Cavalry Regiment at Fort Bliss, Texas, during June 1979.

Although the K-747 represented an important advance in helicopter rotor blade design, it was not without its share of problems. Shortly after initial deliveries during 1979, it was discovered that rain produced a chemical reaction in the blade that set up vibrations. The manufacturer had to re-track and re-balance the blades to correct this anomaly. Then, on August 6, 1981 an AH-1S (MC) aircraft was involved in an accident caused by the loss of the 53 pound blade tip weight. The Army directed that all composite blades be removed from the *Cobras*

and replaced by the older-style metal blades. A contract to develop a fix solution was awarded during September 1981 to Kaman, who subsequently developed a mechanical method (bolted bushings) of attaching the blade inertia weight to the main spar. The new structure passed static and fatigue tests during January 1982, and on April 30 shipments of the redesigned blade, designated the K-747-205, went to Army units.

A second modification to the new blade occurred during December 1982, when Kaman replaced the estane leading edge erosion guard with a new, more durable material known as PO-655. The modified blade was designated K-747-209. Also, during June 1983, a rotor imbalance in one blade set was discovered during a standard test flight. Analysis by Kaman revealed water absorption through imperfections in the blade surface. This problem led to the latest version of the blade, the K-747-303. These blades have new preformed skins to alleviate the water absorption problem and feature a removable stainless steel guard on the outboard leading edge to reduce erosion due to sand and rain.

The new main rotor blade's composite design incorporates not only improved reliability, but also a high degree of field repairability. The leading edge erosion guard can be repaired in the field (including the stainless steel tip guard). There are repair kits for skin patches, skin/core plug patches, and the trailing edge spline which can be repaired in the field. Following repairs, the blades are rebalanced using adjustable trim weights. Currently, well over 2,000 blades have been manufactured for the *Cobra* fleet, with an estimated 600 B-540 blades still in the field to be replaced on an attrition basis.

While the Army was testing and preparing to field the new composite main rotor blades, the AH-1G conversion efforts continued. Bell delivered the first *Cobra* modified to AH-1Q/TOW configuration on June 10, 1975, and by February 1979 all 290 AH-1G/Qs had been modified to AH-1S (MOD) standards. The ICAP/ICAM conversion programs were completed as follows: A total of 92 AH-1Qs (a/c 19001-19092) were updated and modified to the AH-1S (MOD) standards. Aircraft 19001 through 19020 (20 of the original batch of 92), which missed ICAM incorporation, were recycled at Bell's Amarillo, Texas facility to full AH-1S (MOD) configuration. One of these aircraft, however, was used as a testbed for Bell's field modification kit discussed herein. Aircraft 19021 through 19092, which received only the ICAM structural provisions, were modified in two batches. One consisted of nine aircraft modified by a fixed base contractor using the Bell-produced field modification kits. Finally, aircraft 19093 through 19290 (the 198 aircraft which received the full ICAM modification) were remanufactured at the Amarillo facility to AH-1S (MOD) standards.

By September 30, 1976, 148 AH-1Q/S TOW/*Cobras* were in the Army's inventory—92 AH-1Q and 56 AH-1S (MOD) aircraft. Although a total of 37 AH-1Qs had been assigned to CONUS units by the fall of 1976—primarily to the 6th Calvary Brigade (Air Combat), Ft. Hood, Texas and the Army Aviation Center at Ft. Rucker, Alabama—most of the modified *Cobras* were immediately deployed to Europe to fill the new attack helicopter force structure then being organized in USAREUR. On August 30, 1976, while visiting USAREUR, Col. Charles F. Drenz, *Cobra* Project Manager, presented the first AH-1S (MOD) aircraft (in USAREUR) to Brig. Gen. Dan Williamson, Assistant Division Commander, 3rd Armored Division. By October 1, 1976, the Army had provided 91 AH-1Q/S TOW/*Cobras* to equip units in Germany, and by the close of the calendar year 1977 the TOW/*Cobra* fleet in Europe had increased to 230 aircraft.

The successful fielding of the TOW/*Cobra* in Germany was in a large measure due to the efforts of Lt. Col. Phillip Grushetsky's Material Fielding Team (MFT), which had as its mission to: 1) assure that newly fielded aircraft were deprocessed and functioned properly before release to gaining units, 2) assist in the transition of crews at the unit level, and 3) assist the gaining unit in attaining and maintaining an operational readiness posture. *Cobras* were airlifted by C-141 aircraft directly from the contractor's facility at Amarillo, Texas to Ramstein AFB, Germany. There the AH-1Q/Ss were deprocessed to include reassembly and checkout before they were issued to unit ferry pilots. In addition, initial support packages containing TOW/*Cobra* peculiar items (repair parts, special test and support equipment, and necessary technical manuals) were shipped to receiving units prior to the release of aircraft. After delivery to home stations, members of the MFT lived with the unit until all assigned aircraft were received and the user was fully capable of operating and maintaining the aircraft.

Likewise, aircrew and maintenance personnel training in USAREUR was carried out by Maj. Lowell Mooney's New Equipment Training Team (NETT) first deployed to Germany in November 1975. Military members of the TOW/*Cobra* NETT were provided by the 6th Cavalry Brigade, Ft. Hood, Texas, under an agreement between the commanders of the Army Aviation Systems Command (AVSCOM) and Headquarters, III Corps. These personnel had participated in the operational testing of the TOW/*Cobra*; and therefore, were the most highly qualified personnel in the operation and maintenance of the AH-1Q/S. Department of the Army civilian maintenance technicians were also assigned to NETT along with subsystems instructors from each of the supporting commands of the Army's Material Development and Readiness Command (DARCOM). During the inital instruction period (December 1975-August 1976), the TOW/*Cobra* NETT trained a total of 75 pilot/gunners and 310 maintenance personnel. The Seventh Army (USAREUR) aviators required about 40 hours of ground school and 5 hours flight training to qualify in the AH-1Q/Ss. Upon completion of its program, NETT's six AH-1S (MOD) aircraft were turned over to the 3rd Armored Division, Air Cavalry Troop.

Meanwhile, on August 6, 1976, the *Cobra* Project Manager, Col. Drenz, briefed both DARCOM and Headquarters, Department of the Army personnel on alternatives for converting AH-1Qs in Europe to the AH-1S (MOD) configuration (these were part of the group of 72 aircraft that received key ICAM structural modifications at the Amarillo facility). The purpose of the briefing was to obtain Department of the Army approval to either accomplish the conversion in Europe (using the modification kits developed and subsequently utilized by Bell Helicopter on a test batch of nine Q to S conversions at Amarillo), or return the Q Models to the U.S. for conversion. The decision was made to convert the Qs in Europe, utilizing, in order of priority: 1) a fixed base contractor, 2) a Corpus Christi, Texas Army Depot Team, or 3) USAREUR Aviation Intermediate Maintenance (AVIM) personnel.

Pursuant to the August 6 decision, competitive bids were obtained and, on May 2, 1978, the U.S. Army Troop Support and Aviation Material Readiness Command (TSARCOM) in St. Louis, Missouri awarded a modification contract for the German-based aircraft to Dornier Reparaturwerft GMBH, Oberpfaffenhofen of Wessling outside of Munich. The contract called for the conversion of 62 AH-1Qs to AH-1S (MOD) configuration. (Bell and Dornier had done business previously; under license from Bell, the German manufacturer had built 344 UH-1Ds for the German Army and Luftwaffe between August 1, 1967 and January 19, 1971.) By October 1978, Dornier had delivered 32 of the modified gunships, and during February 1979 the West German firm completed the last conversion. Hence, no AH-1Qs were left in the Army inventory.

As for the Army's remaining AH-1Gs, Bell began a new modification program during November 1979 to convert most of these machines to the definitive AH-1S (MC) (redesignated AH-1F) configuration discussed herein. By June 1982 all of the 378 G Models (a/c 19301 thru 19678) slated for conversion to the "Modernized *Cobra*" standards had been completed. The Army subsequently modified 41 of these aircraft to TAH-1F trainers by adding a cyclic hydraulic booster and a master armament safety switch to the instructor's (front) station. Then, on September 26, 1984, Bell received the first in a series of three contracts (subsequent contracts were awarded during September 1985 and 1986) to modify 72 AH-1Gs to AH-1S (MOD)s and 15 TH-1Gs to TH-1S (MOD) aircraft (A/C 19701 thru 19787) for the Army National Guard under the so-called *MINUTEMAN* Program. The initial 1984 contract, worth $16.1 million, authorized the modification of the first batch of 29 AH-1Gs (ie., modified airframes, improved dynamics and TOW integration). A concurrent contract for $15.4 million also was awarded for the necessary TOW missile systems. The first of the AH-1Gs to be converted (69-16412) arrived at the Amarillo facility on January 17, 1985 and was delivered back to the Army on May 27, 1986. The last conversion (69-16444) now is scheduled to be completed during October 1988. Hence, total AH-1G conversions stand at 755: 362 AH-1S (MOD)s (now designated AH-1S), 15 TH-1S trainers, 337 AH-1S (MC)s (re-designated AH-1Fs), and 41 TAH-1F trainers.

As of this writing, only ten AH-1Gs remain in the Army's inventory. All are Category C aircraft awaiting conversion into electrical and armament trainers. Once converted, they will lose their identity as aircraft. Seven machines (67-15488, 15511, 15522, 15542, 15590, 15628, and 15841) are at Ft. Eustis, Virginia; and the remaining three aircraft, originally leased to Spain during 1971 (71-15090, 15091 and 15093), are at the U.S. Army Aviation Classification Repair Activity Depot (AVCRAD) in Gulfport, Mississippi.

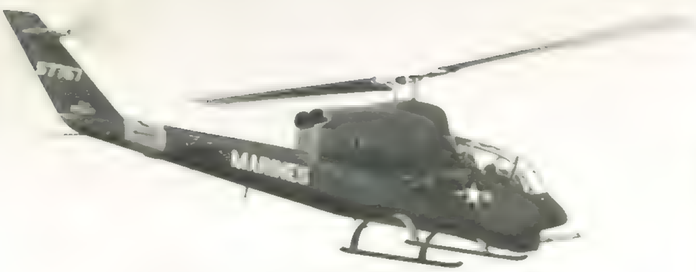
AH-1P/AH-1E/AH-1F

Even as early as December 1974 it already was evident that improvements beyond the basic ICAP/ICAM programs would be needed. To have maintained the status quo rather than improve the *Cobra's* capabilities would have been self-defeating, particulary in light of the then current and postulated radar and infrared threat technology. The Army envisioned the need for several improvements, including a low-glint canopy, better cockpit layout and instrumentation, different communications equipment, and upgrades in both the *Cobra's* armament and onboard defensive systems. The latter, in fact, was of significant importance as enemy anti-aircraft defense systems had been developed to the point where it was necessary to add the weight of countermeasures equipment (principally the APR-39 radar warning receiver [RWR], ALQ-136 radar jammer, and the ALQ-144 IR jammer) to the already heavy basic AH-1 aircraft. The Army's anticipated needs were to result in a comprehensive modernization plan specifically designed to develop an advanced and significantly improved attack helicopter based on the standard AH-1G airframe.

The plan to improve and modernize the "Snake" was made over a thirteen-month period—a product of the Army's Priority Aircraft Subsytem Suitability Review (PASS IN Review) Special Study Group (SSG) at Ft. Rucker, Alabama. The Study Group, directed by both the U.S. Army Armor centers and U.S. Army Aviation centers commanders, was comprised of representatives from the Army's Training and Doctrine Command (TRADOC), Material Development and Readiness Command (DARCOM), commodity commands, field commanders, and the *Cobra* Project Manager's Office. The objective of this review was to determine the configuration and capability the *Cobra* would need to cope with the 1975-1985 battlefield threat. The SSG's final report was submitted to the Department of the Army (DA) during December 1975 and approved during April 1976. The evolutionary process that followed not only resulted in the eventual modernization of the 755 AH-1Gs, but also generated three new production versions of the *Cobra* initially designated AH-1S (PROD), AH-1S (ECAS), and the AH-1S (MC) or "Modernized *Cobra*". During March 1987 these latest production variants officially were re-designated AH-1P, AH-1E and AH-1F respectively. In addition, all AH-1S (MOD)s officially became known as simply AH-1Ss (all aircraft are hereafter referred to by their current designations).

The *Cobra* modernization plan derived from the PASS IN Review Study called for the procurement of 305 (later cut to 297) new anti-armor production *Cobras* to be delivered between August 1977 and March 1981. The first 100 ships (now designated AH-1Ps) were to have the same armament subsystems as the AH-1Q/S, plus the L-703 engine, new gearboxes, and an uprated transmission to improve their agility and performance. In addition, the aircraft would feature the new "flat-plate" canopy and an improved cockpit to enhance nap-of-the-earth operations. Further needed improvements were to be accomplished through phased Product Improvement Programs (PIP). The configuration changes would be introduced or "cut" into the production line with the 101st aircraft (now designated the AH-1E) and the 199th ship (now designated the AH-1F).

The major requirement resulting from the PASS IN Review Study Group's report was the need for follow-on enhancement of the *Cobra's* secondary weapons systems (turret and rocket subsystems). Placing emphasis on the need to conduct tactical missions which required armament other than TOW missiles, the report singled out the need to develop a universal turret which would provide for an interim 20mm weapon, and eventually a 30mm cannon system for the TOW/*Cobra* (a go-ahead decision to arm the *Cobra* with the Hughes M230E1 30mm Chain Gun has yet to be made). The Study Group also pointed up the importance of developing a stores management and remote fuzing capability for the 2.75-inch rockets and improving the fire control subsystems for both the cannon and 2.75-inch rockets. In response to the Study Group's recommendations, the Army initiated the two-phased Enhanced *Cobra* Armament Program (ECAP), resulting in the phased production line configuration changes outlined above.



Bell Helicopter

The first AH-1J, BuNo. 157757, during a test flight from Bell's Ft. Worth, Texas facility. Following a lengthy flight test program, the first AH-1Js were delivered to VMO-1 at New River for maintenance and flight training assignments during September of 1970.

AH-1J, BuNo. 157768, at MCAS Kaneohe Bay, Hawaii, on January 16, 1975. Bulge of Pratt & Whitney T400-CP-400 engine pack was quite distinctive in this version. Nose section ahead of intakes was essentially unchanged from AH-1G.

Suffering an inventory shortage of attack helicopters, the Army wanted to move quickly to procure the first 100 new production machines. The politicians in Washington, however, had different ideas. Bell had been given the go-ahead to develop an improved TOW-version of the Marine Corps AH-1J Sea*Cobra*, and several important lawmakers wanted the Army also to purchase the improved AH-1J in lieu of the AH-1P, thereby reducing costs. To strengthen their argument further, the Congressmen pointed out that, after all, Bell already was involved in the manufacture of 202 AH-1J aircraft under Army contract for Iran. Although the Army wanted to award Bell production engineering contracts during June 1975, the House Armed Services Committee placed a restriction on expending any funds for the new production *Cobra* until the controversy over the AH-1J was resolved.

After much discussion and debate, the Army finally was able to convince Washington they didn't need nor want the twin engine capability of the AH-1J. On Thursday, December 18, 1975, Texas Congressman Jim Wright announced the Army had awarded Bell a $37.3 million production contract for 44 units of what would become the AH-1P *Cobra*. The contract included Army options to purchase an additional 22 helicopters and contained an additional $3.3 million for improved cockpit and other engineering changes. Seven months later, during July 1976, the Army exercised its options for the purchase of the additional 22 new production machines. As it turned out, Bell eventually would deliver a total of 100 new AH-1P (A/C 24001-24100) to satisfied Army units worldwide.

On March 16, 1977, Bell President Jim Atkins presented Maj. Gen. Eivind H. Johansen, commander of the U.S. Army Aviation Systems Command, with the keys to the first AH-1P during ceremonies at the contractor's Hurst Plant. The first AH-1P (76-22567) represented the 1,127th new *Cobra* Bell had delivered to the Army since the announcement to put the AH-1G into production on March 11, 1966. Five months later, during August 1977, the first operational AH-1Ps were turned over to Forces Command, Continental United States (FORSCOM CONUS) units—the first of these being the 82nd Airborne Division at Ft. Bragg, North Carolina. The final AH-1P (77-22762) was delivered to the Army during August 1978.

In addition to the uprated L-703 engine and dynamic components, the AH-1P incorporates a variety of improved survivability design features and reliability, availability and maintainability (RAM) characteristics. The principal external change is the new semi-flat canopy (made up of seven planes of viewing surfaces) that is optimized for low light reflectivity, low radar signature, and improved pilot headroom and visibility. It has the safety feature of being part of the crew escape system during emergency egress situations. A ballistic jettison system explosively cuts the acrylic side windows from the canopy support structure while linear shaped charges and thrusters explosively separate the pilot and copilot/gunner entrance doors.

In the cockpit, both the pilot and copilot/gunner (CPG) have been given state-of-the-art technology instrumentation positioned in rational groupings. A sample of the latter includes a center-mounted, 3-inch diameter torque meter, pilot steering indicator, and radar altimeter—critical instrumentation for accomplishing the antiarmor mission and flying safely at NOE altitudes during periods of reduced visibility. Additionally, the flight instruments are arranged in a standard instrument flight rules (IFR) "T" configuration and include 4-inch diameter VSI and HSI (for precision IFR flight and ILS, VOR and ADF approaches) grouped with smaller (3-inch) airspeed, altitude and vertical speed indicators. The number of engine instruments also have been reduced via the use of 2-inch dual scale instruments. The simple, lightweight APR-39 RWR can be used during NOE flight and has been significantly improved in both capability and dependability, giving the pilot aural and visual warning in time to take evasive action against radar-controlled anti-aircraft weapons. Importantly, panel lighting for night flight has been improved and optimized for operation with night vision goggles (NVG).

The AH-1P features the Standard Lightweight Avionics Equipment (SLAE), including the smaller and lighter ARC-114 FM, ARC-164 UHF-AM and ARC-115 VHF-AM communication radios. All are compatible with secure voice systems. Additionally, navigation capabilities have been greatly improved by incorporation of VOR and ILS receivers, glide slope, marker-beacon and indicator lights. This so-called CONUS/NAV package was installed in all AH-1P aircraft, but subsequently was deleted from the follow-on AH-1E and AH-1F series aircraft.

Other significant improvements include a new electrically-driven hydraulic pump to provide collective boost in the event of a main hydraulic system failure, a three-piece engine deck panel to reduce bonding separations, a new engine compartment fire detector (sensing element) and control unit which activates a fire warning indicator for the pilot, and the push-pull anti-torque controls and flex beam tail rotor introduced on the AH-1S.

The planned Phase I ECAP improvements first were introduced on the 101st new production *Cobra* delivered during September 1978. Known today as the AH-1E, that first ship (77-22763) in the batch of 98 AH-1Es (Bell airframe numbers 22101-22198) was equipped with the M79E1 universal turret and M-197 Vulcan 20mm gun. Fielding of the new AH-1E occurred at Ft. Hood, Texas, May 21 thru June 22, 1979; and at Ft. Bragg, North Carolina between July 23 and August 24, 1979. The last AH-1E (78-23092) rolled off the Bell assembly line during October 1979.

All AH-1Es were also scheduled to be factory-equipped with the Baldwin Electronics, Inc. XM138 Rocket Management Subsystem (RMS) with set fuzing capability. But due to the failure of the Little Rock, Arkansas subcontractor to deliver components to Bell, the so-called "up-gun" or ECAS (Enhanced *Cobra* Armament System) AH-1Es were delivered with RMS provisions only. (On June 23, 1980 a Bell team arrived at Ft. Bragg to retrofit the first 21 aircraft, and by September 1981 all AH-1Es had received the RMS equipment.) The 149th production AH-1E (78-23043) was the first *Cobra* to have the new K-747 composite blade installed. The new blade offers a reduced radar signature and has a significantly improved survivability rating (it allows for 30 minutes of flight after suffering a direct hit by a single 23mm high explosive, incendiary, or tracer round and has proven to be invulnerable to a single hit by a 12.7mm round). Maximum allowable operating time for the new blade is approximately 10,000 hours.

The AH-1E's under-nose, 175 pound M79E1 turret is similar both in principle and purpose to the M28A3 (7.62mm/40mm) turret installed on earlier *Cobra* variants, but differs from its predecessor in that it carries a heavier armament system and a more advanced control system. Developed by General Electric's Armament Systems Department near Burlington, Vermont, the Universal Turret offers increased standoff capability, an improved anti-personnel and anti-material effectiveness, and the ability to accommodate either a 20mm or a 30mm weapon. The new Universal Turret presently mounts a 20mm M197 three-barrel gun. (As previously noted, no decision has yet been reached regarding the installation of the Hughes M230E1 30mm gun on the *Cobra*; the advanced Hughes Chain Gun is capable of firing the U.S. manufactured M789 HEDP round as well as the British ADEN and French DEFA type ammunition, which is interchangeable with the guns used on the Marine Corps AV-8A Harrier and the British MK IV and French 552 and 553 guns; the M230E1 gun is capable of rates of fire up to 650 spm and has an effective range of over 3,000 meters.) The *Cobra's* turret fires through ± 110° forward azimuth and has a variable elevation of 20.5° maximum and a depression of 50° maximum. Position of the Universal Turret is controlled by either crew member through helmet sights or by the CPG through the use of the Telescopic Sighting Unit (TSU) of the TOW missile subsystem. The turret is electrically actuated and is powered by two servo motors to provide for elevation and azimuth control. The 20mm Vulcan gun fires M50 series ammunition at a rate of 730 ± 50 spm with an effective range of over 2,000 meters. The M197 is supported within the turret by a rear ball mount, a slider, and a low force recoil adapter similar to that first fitted on the Iranian AH-1J/TOW and U.S. Marine Corps AH-1J/T/TOW aircraft. The gun's complement of ammunition (750 rounds) is fed through flexible chuting from the ammunition compartment behind the turret, using a unique pull-push motor driven feeding system.

The M138 Rocket Management Subsystem provides greater selectivity in the use of a mixed rocket inventory. The pilot can choose the best warhead for the attack, e.g., high explosive, multipurpose sub-munition, smoke, flechette, dual purpose HE, or even chaff, and can choose the number of rockets and launch mode (single, pairs, multiple pair). He can also remote set fuzes (penetration delay or time of function, i.e., range, for submunitions) prior to the attack. During the mission the cockpit display indicates the rounds, by type, remaining. The M138 RMS consists of one Cockpit Display Unit (DU) (4.5 x 5.75 x 7 inches) and four Operation Units (OU) (3.1 x 4.1 x 7.5 inches) installed in the stub wings (two on each side) and connected to the aircraft's four wing stores hardpoints. The total RMS weighs less than 18 pounds.

Finally, the AH-1E is fitted with a new 10 KVA alternating current alternator to provide additional electrical power to operate the aircraft's new subsystems, and features an improved SCAS which provides automatic compensation for off-axis gun fire. The new SCAS considerably reduces flight control input requirements by automatically compensating for wind gusts and weapon recoil forces and reduces the need for pilot control correction, thereby easing the workload.

The Phase II ECAP improvements were cut into the *Cobra* production line beginning with the 199th aircraft. This last group of product improvements resulted in the

definitive Army variant—the AH-1F. Design, fabrication and modification work was completed on two prototype AH-1Fs (former AH-1Ps, 76-22567 and 76-22600) during early 1979. After Bell testing, both prototypes were delivered to the Army for government evaluation, beginning during July 1979. During the Government Prototype Qualification Test of Development Test II (DT-II), one of the prototypes completed 118 flying hours with a 94.8% mission reliability. The 20mm turret weapon fired with an accuracy of better than three milliradians.

From March to May 1980, First Article Test of the Production Modernized *Cobra* followed. Held at the Yuma Proving Ground, this test verified performance, compatibility, and quality control of production AH-1F aircraft and demonstrated actions taken to correct some maintenance shortcomings revealed during DT-II. At the same time, the aircraft's Test Measurement and Diagnostic Equipment (TMDE) passed First Article Test. During the two tests, the two aircraft flew 137 hours and fired 21,900 20mm rounds and 2,250 2.75-inch rockets. The TMDE sets operated approximately 600 hours each. The final FY80 test was Operational Test II (OT-II), held August thru October 1980. Using nine aircraft, OT-II assessed the operational aspects of the AH-1F. The test consisted of 500 flying hours and the firing of 40,000 20mm rounds, 4,500 2.75-inch rockets and six TOW missiles.

The first AH-1F (78-23093) was delivered to the Army during November 1979, and the new model was first fielded at Ft. Stewart, Georgia on April 21, 1980. AH-1F aircraft subsequently were issued to field units at Ft. Campbell, Kentucky, Ft. Ord, California, and Ft. Lewis, Washington. Between November 1979 and March 1981, Bell delivered a total of 99 AH-1Fs to the Army (a/c 22199 thru 22297). With the delivery of the 99th AH-1F (79-23252), Bell completed the last of the planned 297 new production *Cobras*. But the story didn't end there.

Between 1980 and 1985 the U.S. Army further contracted with Bell for another 50 new AH-1Fs (a/c 22298 thru 22309 and 22319 thru 22347), principally for the Army National Guard (ARNG). Deliveries of the first dozen ARNG AH-1Fs began during April 1981 under an $8.4 million contract (C/N DAAJ09-80-C-0427) awarded to Bell on July 29, 1980. First issues of the *Cobras* were to the Washington and Utah ARNG. With the 378 AH-1G to AH-1F conversions (completed during June 1982) added to the 149 new production AH-1Fs and 2 AH-1F prototypes (modified AH-1Ps), total U.S. Army/ARNG inventory of AH-1Fs is 529.

The AH-1F incorporates a host of technological enhancements designed to make it one of the most effective attack helicopters in the world. The aircraft's new fire control subsystem is considered the major upgrade included in the Phase II ECAP effort. It features a pilot head-up display (HUD), fire control computer (FCC), air data subsystem (ADS), and a laser rangefinder (LRF). This integrated fire control concept optimizes the characteristics of each subsystem for maximum effectiveness. Fire control solutions for rockets and gun include projectile ballistics, aircraft motion, air data, range, and target motion. System control and logic are designed for rapid simple operation in the NOE environment. The pilot's HUD unit displays TOW envelopes, direct and indirect rocket aim points, airspeed, altitude, heading, and range. The CPG sight displays weapons status and range. Momentary fire interlocks prevent projectile interaction during combined firings with TOW, rockets, and gun.

The fire control computer (FCC), developed by Teledyne Systems Company in Northridge, California, provides the fire control solutions for the Universal Turret and the rocket weapon systems. Located in the aft fuselage, the digital computer collects input data from the TSU, laser rangefinder, turret, laser tracker, and the air data subsystem and automatically computes necessary gunnery solutions for the crew. For example, the air data subsystem (ADS), manufactured by Marconi-Elliott Avionics of Rochester, England, provides the FCC with important data such as three-dimension airspeed, downwash, static pressure, and air temperature. Armed with this data, the FCC can produce fire control solutions that serve to increase the accuracy of the turret and rocket weapon systems. The ADS pitot static probe is visible as a right side-mounted boom that protrudes from the F Model's upper canopy frame.

As with other tactical aircraft, the helicopter, too, has become a mount for advanced laser weaponry. The Army's newest "Snake" is no exception. One such system aboard the AH-1F is the Rockwell AN/AAS-32 Airborne Laser Tracker (ALT). It is designed to automatically

Fred Harl

AH-1J, BuNo. 157765, with deactivated nose gun turret. Missing is the M197 20mm cannon normally associated with this version. Aircraft apparently was utilized for AH-1T conversion training and gun was replaced with ballast. The only remaining AH-1Js serve with Marine Corps Reserve Squadrons.

search, acquire, and track target reflected laser energy (the latter originating from a ground-based source or a nearby airborne target designating system). Once a lock-on has been achieved, this system serves to slew the TOW sight to its target. Approximately 300 AH-1Fs also have been fitted with a laser rangefinder device integrated into the M65 Telescopic Sighting Unit by Hughes Aircraft Company. This so-called Laser Augmented Airborne TOW(LAAT) System serves to increase weapons accuracy while allowing the *Cobra* to fire its TOW missiles at maximum stand off range.

A number of other mission critical systems contribute to the overall combat effectiveness of the AH-1F. Accurate tactical navigation plus both passive and active defense systems greatly enhance survivability. The ASN/128 Doppler Navigation System provides present position plus velocity, course and distance to any one of six preselected positions. The 28 lb. unit's positioning is accurate to 2% of the distance traveled and can be updated in flight. Also, after range to target is measured by the LRF and entered into the FCC, the Doppler updates that range throughout the firing run.

The AH-1F also is equipped with advanced infrared suppressors in the form of a cooled-plug-type suppressor in the engine exhaust and an IR suppressing exhaust shroud manufactured by the Garrett Air Research Company. The design of these components uses large volumes of ambient air to cool the exposed metal surfaces of the engine and to dilute the exhaust gases to facilitate lowering the plume temperature. Where threat levels (seeker range/sensitivity) exceed the thresholds of passive suppression, an active ALQ-144 IR jammer is available to confuse IR seeking missiles. Mounted atop the engine cowl, the 28 pound jammer requires only 54 amps.

The Army's AH-1 has undergone significant upgrading and modernization since returning from Southeast Asia. From a single development effort of modifying the AH-1G to the AH-1Q/TOW, the *Cobra* program has grown to nearly 50 product improvements plus 347 new production aircraft. With delivery of the last G to S conversion scheduled for late 1988, the Army/ARNG *Cobra* inventory will reach nearly 1,100 ships.

Although the modernized AH-1F represents one of today's most formidable anti-armor helicopters, additional improvements are planned to greatly enhance its combat value. Currently the *Cobra's* ability to acquire and attack targets is significantly degraded whenever the battlefield is obscured by fog, haze, dust or smoke, and the crew's nighttime capability is limited to operating with image-intensifying PVS-5 or AUS-6 night-vision goggles and attacking targets using artificial illumination. Hence, top priority has been placed on acquiring a night/adverse weather targeting capability *Cobra*, and improving the ship's performance with an upgraded powerplant.

The Army first flirted with the idea of a night/adverse weather attack system for the *Cobra* during the mid-1970s. During 1974 an AH-1G was fitted with a Ford Aerospace Airborne Target Acquisition and Fire Control System (ATAFCS), an experimental system that combined both day (TV camera) and night (infrared) sighting units with state-of-the-art laser tracking, target designation and target ranging equipment. The rather large globe and canister configuration was mounted initially on a stub wing hardpoint, but subsequent development allowed a smaller version to be carried in the *Cobra's* nose. Although a total of six test units were purchased, the system never was adopted for operational service.

On November 30, 1978, the U.S. Army *Cobra* Program Manager briefed an Assistant Deputy to the Under Secretary of the Army on a new targeting system known as the FLIR (Forward-Looking Infrared) Augumented *Cobra* TOW Sight (FACTS). The unit showed much promise and, as a result of the briefing, the Department of the Army included the new system in its FY 80 budget. FACTS involved the redesign of the M65 TSU to incorporate a common module FLIR to allow operations in poor visibility and at night, with an option for adding a laser later for augmenting the TOW. The FACTS feasibility aircraft underwent a Customer Test during late 1979, and participated in several demonstrations, including Exercise Brave Shield at Ft. Polk, Louisiana. The FACTS did so well that everybody wanted one.

During June and July 1981 efforts were initiated at Ft. Rucker to extend the life of the *Cobra* fleet to the year 2000 via the application of various product improvements. FACTS was included as part of the so-called *COBRA 2000* Program. A Program Acquisition Plan for FACTS was approved, and during September 1981 a contract was awarded Bell to begin preliminary design work. At

U.S. ARMY/ARNG AH-1 Inventory

	AH-1G	AH-1S	AH-1P	AH-1E	AH-1F	Total
Production	1,078		100	98	149	1,425
Returns from Spain	3*					3
Conversion						
AH-1G to AH-1F	–378				+378**	
AH-1G to AH-1S	–377	+377***				
AH-1P to AH-1F			–2		+2	
Subtotals	326	377	98	98	529	1,428
Supplied to Israel	–6****					–6
Combat/Crash Losses	–310	–2	–3	–2	–14	–331
Inventory	10*****	375	95	96	515	1,091

*Leased to Spanish Naval Air Service in 1971
**Total includes 41 TAH-1F Trainers
***Total includes 15 TH-1S Trainers
****Aircraft were converted to AH-1Q/TOW configuration prior to delivery in 1977
*****Ten remaining G Models to be converted to AH-1F electrical and armament trainers

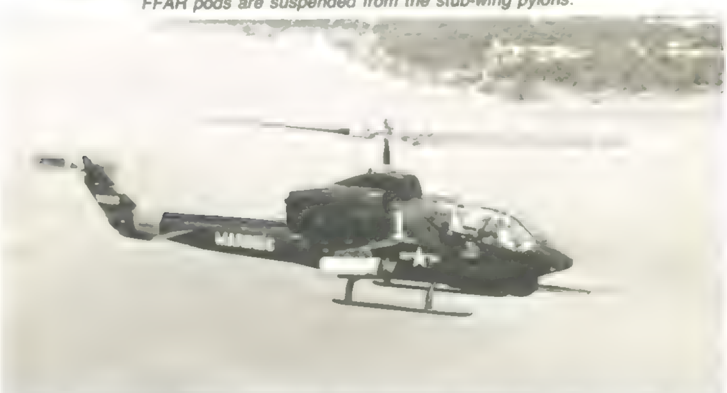
Bell Helicopter

Three AH-1Js, including BuNo 159219, during operations off the coast of Vietnam. AH-1Js continue in Marine Corps service, but are scheduled to be replaced by AH-1Ws as time and money permit. Noteworthy is position of 20mm gun during cruising flight

The prototype YAH-1T, BuNo 159228, during the course of its first hovering flight at Bell's Arlington, Texas flight test facility on May 20, 1976. Bell test pilots Gene Colvin and Bob Walker were at the controls at the time

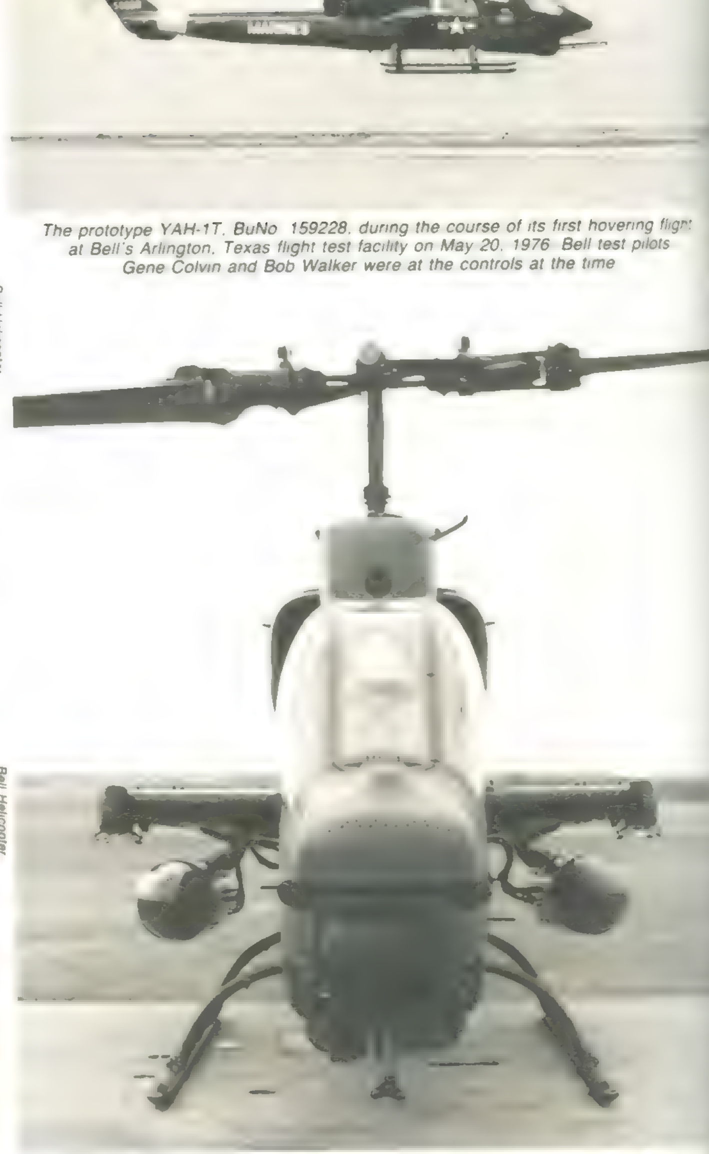
Bell Helicopter

Prototype YAH-1T, BuNo. 159228, with a non-standard ball-like nose turret sensor system, prepares for departure from Bell's flight test facility. Two 19-tube FFAR pods are suspended from the stub-wing pylons.



Bell Helicopter

Prototype YAH-1T, BuNo. 159228, with initial flight test markings. The horizontal tail surfaces, stub-wing upper surfaces, fuselage panel, and bars on the vertical fin were painted orange. Warning band on tail boom was painted yellow.



Prototype YAH-1T, BuNo. 159228, again seen with same non-standard ball-like nose turret sensor system, as it departs Bell's flight test facility. The two 19-tube FFAR pods were painted bright orange. Camouflage was standard with black insigne, etc.

Bell Helicopter

AH-1T testbed is seen while carrying 8 "Hellfire" anti-armour missiles and two 7-round 2.75" FFAR pods on its stub-wings. Aircraft also is equipped with a standard 20mm gun turret and a non-standard orange test boom for pitch and yaw angle verification.

Two Marine Corps AH-1Ts, BuNos. 161015 (foreground) and 160826, during a pre-delivery test flight. Both aircraft are equipped with TOW launchers on their stub-wings and both are painted in dark desert tan camouflage, over-all

the same time subcontractors for detailed FACTS designs were awarded to Texas Instruments and Hughes Aircraft Company. By early 1983, however, the projected unit cost of the new FLIR augumented sight had climbed to approximately $3 million. Later that year, after re-evaluation, the FACTS program was cancelled.

On June 11, 1984 the Army issued a new RFP to industry in an attempt to acquire a less expensive night/adverse weather targeting system. Eighteen days later, on June 29, the House Appropriations Committee approved the use of $19 million in Research, Development, Test and Engineering (RDT&E) funds for qualification and demonstration of the so-called *COBRA*-NITE (C-NITE) targeting system. On December 5, 1984 AVSCOM awarded the Hughes Aircraft Company of El Segundo, California an R & D contract for the engineering design portion of the C-NITE program. Worth $15.7 million, the contract called for the construction of four prototypes, the integration of one system into an AH-1 test vehicle, the qualification of the systems and associated test and evaluation, and delivery of the four prototypes by the close of 1985.

Although C-NITE funding slipped one year, from FYs 85-87 to FYs 86-88, the prototypes were delivered and testing was carried out at Yuma Proving Ground during late 1986 and early 1987. On March 5, 1987 the Army announced that a *Cobra*, flying both day and night missions, had test fired successfully 25 of 27 TOW missiles (93%), using the new targeting system developed by Hughes' Electro-Optical and Data System Group. Using a thermal imaging device (FLIR), the C-NITE system enabled *Cobra* gunners to see through smoke, haze, darkness and adverse weather to accurately fire TOW missiles and to direct cannon and rocket fire.

C-NITE was tested extensively for its ability to launch, acquire and guide missiles to targets; and testing parameters included sensor sensitivity, target recognition and detection, tracking accuracy, missile launching, reliability, and maintainability. All three TOW missile configurations[5] were fired both day and night from a maneuvering and hovering aircraft against mobile and stationary targets. The C-NITE system defeated smoke, jamming and IR countermeasures. As a result of the successful desert test program, a $67 million contract was signed with Hughes Aircraft Company on July 2, 1987. Under the terms of the award, Hughes will manufacture 52 C-NITE systems to be delivered to the Army by July 1990. The contract also specifies options for the purchase of 240 additional targeting systems by July 1988. Current plans now call for a total Army buy of up to 500 C-NITE systems to keep the *Cobra* fleet combat effective through the year 2000.

Although the AH-1 *Cobra* family currently is without an air-to-air capability, the Army continues to evaluate tactics and hardware to assist *Cobra* crews in countering an attack helicopter threat. It is well known that the U.S. Army Training and Doctrine Command (TRADOC) directed the Army Aviation Board to begin such evaluations over a decade ago. The first Air Combat Engagement-Tactic Development Evaluations (ACE-TDE) were conducted between November 1 and December 16, 1977, using AH-1 (attack) and UH-1 (surrogate threat) aircraft to provide initial low resolution evaluation of aerial combat between helicopters. Follow-on tests also were carried out (in concert with the AF) as part of the Joint Countering of Attack Helicopters (J-CATCH) Program designed to provide higher resolution data on weaponry and tactics.

During 1986 the Aviation Board conducted two additional tests. The first of these was the Air-to-Air Combat (ATAC) Innovative Test conducted at Ft. Hunter-Liggett, California. Its purpose was to provide information on the effectiveness of Army Aviation forces during the conduct of air combat operations and to further evaluate helicopter versus helicopter encounters. The second test, the Air-to-Air *Stinger* (ATAS) Operational Test II, was conducted at Ft. Bliss, Texas. This test was designed to test the military utility and suitability of the ATAS missile system in a tactical environment during both day and night mission scenarios. Pilots flew a total of 570 hours, and all four missiles fired at drone targets resulted in direct hits.

[5] The original Hughes Aircraft BGM-71A was supplemented during April 1981 with the Hughes BGM-71C Improved TOW fitted with an extended probe fuse developed by Fairchild Weston. During May 1983 the Army introduced the third-generation BGM-71D TOW 2. The new missile features a larger warhead with a longer probe fuse, a more powerful rocket motor, and a new thermal beacon tracking unit. Because the TOW 2 requires an infrared sight, digital guidance system and new launcher, the Army currently is modifying its AH-1Fs to accept the new anti-armor weapon

The most recent mock aerial battles between helicopters of the Army's Air-to-Air Combat Test (AACT) program took place in the sky over the Naval Air Test Center (NATC), Patuxent River, Maryland. The results from the current program will aid in establishing air-to-air requirements needed in current and future helicopters. Although no decision has been reached, it is reported that the U.S. Army continues to show a particular interest in General Dynamics Valley Systems Division's *Air-to-Air Stinger* missile as a possible anti-helicopter weapon.

Finally, the potential value of increasing hot day performance by improving the *Cobra* powerplant was recognized by the Army as early as April 1978. As of this writing, however, a replacement for the L-703 engine has not been announced. It is important to note, however, that Allison/Garrett and AVCP/Pratt & Whitney—competitors for the U.S. Army T-800 engine program—have been asked for proposals to adapt their engine designs to fit the UH-1 and AH-1 helicopters. The T-800, which is being developed for the Army's Light Helicopter Experimental (LHX) Program, represents the next generation of helicopter engines. It will provide a significant increase in helicopter powerplant performance and a quantum reduction in operating and support costs. While the T-800 may well be selected as the L-703 replacement, such a decision can not be made until the Army actually selects the competition winner sometime during 1988.

MARINE TWIN ENGINE VARIANTS: AH-1J/AH-1T AH-1W

AH-1J *SEACOBRA*

The arrival of the first four AH-1Gs at Marble Mountain during April 1969 was an important event in the history of Marine Corps aviation. For the first time the Corps' helicopter gunship pilots had an attack aircraft specifically designed for the mission. Although their modified UH-1Es had served them well during the previous four years, the AH-1G promised to be a far superior weapons platform. It had a much improved armament system, greater firepower and flexibility, and steeper dive angles for greater accuracy in weapons delivery (the UH-1E pilots had been forced to fly rocket and gun runs below 1,000 feet for the required accuracy). Most importantly, the new ships were "transport compatible"; that is, the *Cobra's* speed and endurance allowed it to lead the troop transports into the assault area and then loiter overhead to provide suppression fire until the last transport had safely departed the landing zone safely.

Although the AH-1G was a welcome addition to the Marine inventory, the service had made it known from the beginning they found the helicopter lacking in several respects. To begin with, they argued that the turret armament was too light for their purposes. With heavy emphasis placed on the use of gunships for armed escort, LZ prep and fire support, the Marines wanted a turret gun of the 20mm variety. The Corps also made note of the aircraft's lack of a rotor brake, a device necessary for safe shipboard operation. The *Cobra's* design commonality with the Army's UH-1B/C presented possible spare parts problems, and it wasn't long after the *Cobras* began arriving at DaNang that the anticipated supply shortcomings materialized. Most of the spare parts that were not the same as those for the Marine UH-1E had to be ordered from Army supply depots, often resulting in long delays and unnecessary *Cobra* downtime. The fact that AH-1Gs had strictly Army avionics (UH-1B) only compounded the Corps' already difficult logistics problems.

The most serious deficiency the Marines saw in the "off-the-shelf" AH-1G was its single engine. Given the amphibious nature of the Marine Corps' mission, the Leathernecks contended from the start that what they really needed was a twin-engine *Cobra*. The question to "twin" or "not to twin" helicopters had never been a burning issue with the Army. While consideration had been given to "twinning" the UH-1 during 1968, the Army elected to stay with the single engine concept due to the cost associated with retrofitting the older aircraft in its fleet. Although "twinning" its helicopters would provide power enough to complete a mission on one engine or allow for safer emergency procedures, the Army concluded the reliability record of the Lycoming T53-L-13 single turbine was excellent and getting better. In fact, Army statistics disclosed very few accidents attributable to engine failure.

The Marines painted a much different picture. While they agreed that the single engine helicopter might well be able to auto-rotate to a safe landing in the event of engine failure over land, they argued that a similar power failure in the open sea would invariably result in the loss of the aircraft and often the crew as well. To support their claim, they cited their own accident statistics. Records of the Naval Aviation Safety Center disclosed that during the period 1956-1967 a total of 17 USN/USMC UH-1 type aircraft had been lost or damaged in combat or operational mishaps directly attributed to the failure or malfunction of their single engine.[6] The net result had been eight fatalities and a score of crew injuries. On the other hand, the Marines pointed out that recent combat experience with the twin engine CH-46 *Sea Knight* and CH-53 *Sea Stallion* had proved that with two powerplants, if one failed, not only could the crew be saved, but often the aircraft as well.

Although the Marine Corps accepted the Army AH-1 version in order to get a dedicated attack helicopter to its combat units in the shortest time, it began campaigning for its own custom-built, twin-engine *Cobra* almost before the ink was dry on the AH-1G contract. One of the leaders in the Marine struggle to obtain a marinized *Cobra* was Col. (later Lt. Gen.) Thomas H. Miller, who was at the time Head, Air Weapons System Branch. The holder of four Distinguished Flying Crosses (one of which was for setting a 1,216.78 mph world speed record in an F-4B on September 5, 1959), Miller was a respected voice in Marine Corps aviation circles. He argued that the twin engine powerplant was justified on four important grounds: increased payload, growth potential, increased reliability in mission performance, and, of course, improved crew safety.

Supporting Col. Miller's position, the Marine Corps Chief of Staff (Air), the legendary Maj. Gen. (later Lt. Gen.) Keith B. McCutcheon, convinced Marine Commandant Wallace M. Greene, Jr. to take the fight for a marinized *Cobra* directly to the Secretary of the Navy and the Office of the Secretary of Defense (OSD). By the fall of 1967 the Marines had succeeded in gaining a partial victory. The Corps would receive an additional 38 marinized *Cobras* (to be designated AH-1Js) fitted with the required Navy avionics, rotor brake, and 20mm turret. The bad news was that the new gunships still would be powered by a single T53 engine. Although the needed twin powerplant was available, the OSD concluded the cost of procuring enough for such a limited quantity of *Cobras* was too high. Maj. Gen. McCutcheon reluctantly agreed to the OSD plan, but argued that the Marine Corps should only be required to operate the single engine version until the end of the war.[7] The subsequent turn of events in Vietnam would force both the Secretary of Defense and Congress to re-evaluate the Marines' attack helicopter procurement plans.

During the evening of January 29 and the early morning hours of January 30, 1963, the North Vietnamese Army and Viet Cong forces launched their *Tet Nguyen Dan* Offensive in the northern provinces of South Vietnam. One of the first targets was the Marine Corps Air Facility at Marble Mountain. As a result of the initial attack at DaNang and the February and March battles at Hue, Quang Tri and the combat base at Khe Sanh, the Marines lost several of their valuable UH-1E armed helicopters to hostile fire. Faced with immediate need for replacement aircraft, including gunships, the Corps renewed its attempts to secure twin-engined *Cobras*. This time the Marines' efforts proved fruitful. During April 1968, Robert McNamara requested Congressional approval to divert the Corps' aviation funds from less urgent programs to the development of a twin engine *Cobra*. He also asked the lawmakers to increase the Marine allocation from the planned 38 to 49 new gunships during 1968. On May 29, 1968 Texas Congressman Jim Wright announced that Bell had been awarded $15.5 million in initial funding to develop and subsequently manufacture 49 twin-engined AH-1J *SeaCobras* for the Marines.

The Marine Corps proposed that the *SeaCobra* be powered by the Pratt & Whitney PT6T-3 *Twin-Pac* engine

[6] It is assumed that most if not all of these losses occurred between 1964-1967 as the Marine Corps and Navy did not operate UH-1s until 1964 and 1965 respectively.

[7] Gen. McCutcheon later explained at a 1968 General Officer's Symposium that the staff of OSD remained unconvinced that, in the Marine Corps, armed helicopters and fixed wing attack aircraft complemented, not competed, with each other. Hence, the Marines were required to offer both "equal effectiveness" as well as "equal cost" trade-offs of fixed wing aircraft in order to retain the armed helicopters. Otherwise, the Marines were forced to work under the policy that for every additional helicopter added to its inventory, a fixed wing aircraft had to be deleted.

Bell Helicopter

The AH-1T, with its "Twin-Pac" powerplant, is ideal for Marine Corps use because of the theoretical increased margin of safety provided by two engines. Accordingly, over-water flight, which is customary for Marine missions, is less hazardous.

(the same basic engine that Bell later used in its twin engine Model 309 *KingCobra* demonstrator). The only problem was that Pratt & Whitney's parent company was United Aircraft of Canada.[8] Given the Canadian's rather outspoken position toward the U.S. involvement in South Vietnam, several influential members of Congress objected to equipping a Marine Corps attack helicopter with a Quebec-manufactured powerplant. Leading the opposition was the powerful Chairman of the House Armed Services Committee L. Mendel Rivers, who voiced his concern in an April 9, 1968 memorandum to Secretary of Defense McNamara.

In an attempt to end the controversy, the Naval Air Systems Command was directed to draft specifications and issue a Request for Proposals to engine manufacturers in both the United States and Canada. All interested firms were required to respond by August 3, 1968. As the deadline came and went, only two companies had submitted proposals: United Aircraft of Canada and Continental Aviation and Engineering Corporation, an American concern.

The choice was not difficult. Although Continental's design was sufficient, it was still basically a drawing board project. On the other hand, UAC's thoroughly tested PT6T-3 *Twin-Pac* was production ready. After working out some minor changes in proposed engine components (e.g., the use of cast aluminum casings instead of cast magnesium) a contract was awarded the Canadian-based manufacturer—but with the proviso the military powerplants (now designated PT6T-4 by UAC) were to actually be assembled by American labor at Pratt & Whitney's Bridgeport, West Virginia facility.

The new *Twin-Pac*, designated the T400-CP-400 by the U.S. Navy, provided the AH-1J with the twin engine safety and reliability the Marines had fought so hard for. Tipping the scales at just 714 pounds (only 175 pounds more than the single turbine T53), the lightweight power pack consisted of two independent PT-6 turboshaft power sections mounted side-by-side and driving a single combining gearbox with a single output shaft. Rated at 1,800 shp for take-off, the new powerplant advertised a maximum continuous rating of 1,530 shp at sea level. The *Twin-Pac* was married to a 1,290 shp transmission, with a continuous rating of 1,134 shp. In the event that one of the T400 power sections failed, the other was capable of providing 765 continuous shp to the main rotor—sufficient power to allow the AH-1J to maintain level flight except under high gross weight and density altitude conditions.

With the powerplant issue finally resolved, developmental work on the AH-1J began in earnest at Bell. Preliminary engineering studies suggested that the AH-1J was to be dimensionally similar to the Army AH-1G, but the new ship's empty weight would be some 800 pounds heavier. Likewise, the gross weight of the Marine version would be 10,000 pounds, or 500 pounds more than the single engine gunship. Bell proposed to retain the proven 540 rotor system, but the AH-1J would feature a tail rotor with slightly increased cord (to 11.5 inches) and new push/pull type rotor controls. Finally, the much sought after rotor brake would be added.

Modification to the basic AH-1G airframe was generally limited to the section aft of the cockpit where the new Canadian *Twin-Pac* was to be incorporated. However, some structural strengthening was required in the lower forward fuselage area to accommodate the heavier 20mm gun turret and ammunition drum. Fire control systems were added to both crew stations, and the instrument panels were re-worked to accept the needed compliment of navalized avionics, including the AN/ARN-52(V) TACAN navigation system, AN/APN-171 (V) radar altimeter, AN/APN-154 (V) radar beacon, AN/ARN-83 direction finder set, and the AN/ASN-75 gyro-synchronized compass set.

The AH-1J was intended to be an aggressive, high speed attack helicopter designed and built around the fighting mission. The Marines demanded that the gunship's mission profiles completely cover the air-to-ground environment with multiple weapon suppressive fire. The aircraft's stated missions included search and target acquisition, multiple weapon fire support, reconnaissance by fire and troop helicopter escort. Therefore, a high degree of weapon carrying versatility was required. For internal armament, the Marine Corps selected a new electrically-powered, chin-mounted turret system manufactured by the General Electric Company. The weapon system consisted of a turret assembly, crew turret controls and sighting subsystems, and the three-barrelled 20mm M197 automatic cannon with associated drive assembly and ammunition feed system. The M197, a lightweight derivative of the six-barrelled M61 Vulcan cannon used on the AF's F-4E, demonstrated a maximum rate of fire of approximately 750 spm, but was burst limited to 16 rounds.

During co-pilot/gunner-controlled operation the cannon was aimed and fired by means of a sighting station, which had a sight assembly mounted on a flexible pedestal. The gunner's sight contained a reticle image illuminated by a 35-mile radius segmented circle. Two hand-grips provided for positioning the reticle on target and also contained trigger switches and spring-loaded action switches to energize turret positioning circuits in the turret assembly. The azimuth drive system allowed the co-pilot/gunner to rotate the turret through a range of 110° either side of 0° azimuth, and he could fire the M197 gun through an elevation and depression range of ± 18° and -50° respectively. When pilot-operated, the gun and turret remained fixed in a lower stowed position (i.e., 0° azimuth and elevation) and was fired via a fixed gunsight also containing an illuminated reticle image.

The AH-1J's stub wings featured four armament hard points and were stressed to carry a variety of external ordinance, including the LAU-61 and -69 19-shot rocket pods, 7-shot LAU-68 rocket pods, the self-contained 7.62mm SUU-11A minigun pod, and 500 lb., free-falling CBU-55 fuel/air explosive bombs. The AH-1J's rocket delivery system enables the pilot to pre-select and then release the aircraft's wing stores in the quantity, mode, and rate desired and also provided the capability for in-flight arming of droppable weapons. In a pilot override condition, the delivery system also allowed the co-pilot/gunner to selectively release all inboard or outboard stores.

On October 14, 1969, Bell rolled out the first AH-1J *SeaCobra* (BuNo. 157757). On hand to inspect the new machine was a group of Marine officers which included Col. Henry Hart, Program Manager for Assault Helicopters, Naval Air Systems Command and Col. Ed Finlayson, Head, Weapons Group, Headquarters, Marine Corps. Leading the group was the distinguished Brig. Gen. Victor A. Armstrong, who had served as the C.O. of Marine Air Group 36 in Vietnam during 1966. General Armstrong was delighted with the new gunship and impressed upon Bell officials the need to get the AH-1J into the hands of Marine combat pilots as quickly as possible.

Within a month of roll-out BuNo. 157757 flew for the first time with veteran Bell test pilot Gene Colvin at the controls. By the following July Bell had delivered the first four *SeaCobras* to Patuxent River, Maryland for Navy Board of Inspection and Survey (BIS) trials, and two months later, during September 1970, seven more AH-1Js were turned over to Lt. Col. Robert D. Myer's VMO-1 at New River, North Carolina to be used in the training of pilots and maintenance personnel. Following the completion of their training at New River during January 1971, a cadre of pilots and maintenance specialists made ready to test the Corps new gunship under actual combat conditions.

On February 12, 1971 the Marine AH-1J evaluation team, under the command of Col. Paul W. "Tiny" Nieson, departed the U.S. for Vietnam. The group of eight officers and two dozen enlisted arrived in-country on February 16 and was assigned to Lt. Col. Clifford E. Reese's HML-367 at Marble Mountain. On February 18 the unit's four *SeaCobras* arrived at Da Nang aboard AF C-133 transports and immediately were unloaded and ferried to the Marble Mountain facility. After familiarization and orientation flights were completed, Lt. Col. Reese and Col. Nieson flew the AH-1J on its first combat mission.

Although the AH-1J *SeaCobra* arrived for combat evaluation during the closing stages of the war, its participation in Operation LAM Son 719, the spoiling attack into Laos, presented a relatively high intensity ground fire environment in which to test its mettle.[9] The 1st Marine Aircraft Wing's support of the operation began on January 31, 1971, when CH-53Ds from HMH-463 began moving gear for the Army's 101st Airborne Division (Airmobile) into staging areas near Quang Tri, Camp Carroll and Khe Sanh. Following the South Vietnamese Army's crossing into Laos on February 8, the Marine-provided lift continued at a level of from two to eight CH-53s daily. In keeping with Marine Corps doctrine, *Cobra* gunships from Lt. Col. Reese's HML-367 flew armed escort for the giant *Sea Stallions*.

[8] The PT6T-3 "*Turbo Twin-Pac*" originally was intended for use in the proposed CUH-IN twin then under consideration by the Canadian Armed Forces. The Canadians did finally order 50 of these helicopters (re-designated CH-135s) during 1969, with first deliveries taking place in Ottawa on May 3, 1971. The U.S. version, designated UH-1N, was produced in quantity for the AF, Navy, and Marine Corps, beginning during 1970. The Marines also purchased 6 V.I.P. executive transport versions under the VH-1N designation. All U.S. military versions were powered by the follow-on PT6T-4, re-designated the T400-CP-400 *Twin-Pac*. Bell also manufactured a commercial version of the same aircraft known as the *Twin Model Two-Twelve*. It received FAA certification during October 1970.

[9] Throughout the operation optically-controlled 23mm and radar-controlled 37mm NVA anti-aircraft cannons were plentiful on the Laotian side of the border. U.S. sources reported the loss of 107 helicopters from January 30 to April 6, 1971, the day the operation officially closed: 61 *Hueys*, 26 *Cobras* (no AH-1Js), 9 OH-6A *Loaches*, 6 OH-58 *Kiowa Scouts*, 3 CH-47s *Chinooks*, and 2 Marine CH-53 *Sea Stallions*. An additional 618 helicopters were reported as "combat damaged", but it is impossible to know to what extent

A typical daily "package" provided LAM Son 719 was four CH-53s escorted by four AH-1G *Cobras* or the newly arrived AH-1J *SeaCobras* (the AH-1Js flew for the first time in support of the operation of March 2, 1971). The package would leave Marble Mountain early in the morning and stage through LZ Kilo near the old Marine combat base at Khe Sahn. Although there were numerous lifts into Fire Support Base (FSB) Sophia 40 kilometers inside Laos (near Tchepone), only one CH-53 was lost to enemy ground fire—that by a single, chance mortar round as the *Sea Stallion* prepared to land in a "hot" LZ. (A second Ch-53 was lost during the operation, but it crashed on the South Vietnam side of the border.)

The AH-1J evaluation period ended on April 28, 1971 and the four test aircraft were returned to the U.S. The *SeaCobra*, with its heavier firepower and twin-engine reliability, quickly proved its combat worth. After flying more than 600 combat hours and expending nearly 73,000 rounds of 20mm ammunition and 2,800 rockets, the AH-1J combat pilots were satisfied it was just what the Corps had ordered. Upon his return to the U.S., Col. Paul Nieson reported to Marine Commandant Gen. Leonard F. Chapman, Jr. that the *SeaCobra* had provided "significantly greater effectiveness in firepower over the AH-1G".

By June 30, 1971 the Marine Corps had taken delivery of an additional 28 AH-1Js. These aircraft were dispatched to the Marine Air Facility at New River where, on July 1, 1971, the Corps formed its first attack helicopter squadron (HMA-269) under the command of Lt. Col. Lloyd W. Smith, Jr. As more *SeaCobras* became available during late 1971, a second attack unit (HMA-169) was commissioned on the West Coast at Camp Pendleton, California. The last aircraft (BuNo. 157805) in the initial batch of 49 AH-1Js was delivered to the Corps during late 1972, and a repeat order for 20 more *SeaCobras* was placed with Bell during 1973. The final AH-1J (BuNo. 159229) rolled off the Fort Worth assembly line during February 1975.

After nearly two decades of faithful service, the AH-1J continued to soldier on in both active and reserve squadrons. Past and current AH-1W procurement, in conjunction with the Corps' planned AH-1T to AH-1W retrofit program, should provide sufficient total numbers of aircraft to standardize the active operational and training units with AH-1W aircraft. The remaining AH-1Js (approximately 45 or so) will be free to fill the Corps' reserve attack helicopter force deficit. The only reserve unit now flying AH-1Js is the Atlanta-based HMA-773 which has 12 ships. However, as more AH-1Ws roll from Bell production lines, the Corps plans to form a second AH-1J reserve squadron (HMA-775) either at Camp Pendleton or Glenview NAS during 1989-90.

AH-1T/AH-1T(TOW) Improved *SeaCobra*

Nearly a year before Bell delivered its last AH-1J, the Marine Corps already had begun seeking ways to improve the *SeaCobra's* performance, combat range and payload. Thanks to the Shah of Iran, the Marines were able to procure the AH-1T Improved *SeaCobra* at a minimum unit flyaway cost of $2.3 million. During December 1972, Bell announced that it had received a massive order from the Army for 287 Model 214A *Hueys* and 202 AH-1Js to be acquired by Iran via the U.S. government. The Iranian Model 214A "Isfahan" was to be powered by the 2,050 shp Lycoming T55-L-7C engine. As part of the deal, the Iranians agreed to pay the R & D costs associated with developing a companion 1,970 shp transmission for their proposed *Huey*. (Production 214As actually were manufactured with the more powerful 2,930 shp Lycoming LTC4B-8D engine and a beefed-up 2,050 shp [take-off] transmission.) Gen. Manouchehr Khosrowdad, head of the Shah's Imperial Iranian Army's Aviation Branch also insisted that the Iranian AH-1J be re-engined for better hot and high performance. Again, the Shah agreed to fund the development of a more robust Pratt & Whitney Turbo *Twin-Pac*. The resultant powerplant was the 1,970 shp T400-WV-402. The first "International" AH-1Js were delivered to the Islamic Army during April 1974 and were followed a year later by the first production Model 214A *Hueys*.

With the expensive R & D costs of the improved transmission and uprated *Twin-Pac* already underwritten by the Shah, the Marine Corps could recognize an opportunity when it presented itself. During the spring of 1974 the Corps directed Bell to carry out a modification effort on its last two production AH-1Js (BuNos 159228/29). Both machines were to be fitted with the uprated P & W T400-WV-402 *Twin-Pac* and improved transmission from the Iranian Model 214A. In addition, the Corps specified the incorporation of other Model 214 components, including the larger 48 ft. dia. main rotor with increased cord (33 in.) and 8 ft. 8 in. tail rotor re-positioned at the top of the vertical fin in a manner similar to the earlier UH-1C/Ds (production AH-1Ts utilized a larger 9 ft. 8 in. dia. tail rotor). The new engine and transmission coupled with the improved dynamic system promised to significantly increase the *SeaCobra's* performance.

As the modification work got underway, Congress got into the act by insisting that the BGM-71A TOW launching system be added to the modified AH-1Js. The Marines resisted, arguing that unlike the Army's AH-1s, its *SeaCobras* were intended primarily for the armed escort of troop assault aircraft. The Marines saw no reason to get into the business of providing point target attack against threatening armor. More importantly, they argued that the modification program was designed to enhance the performance of the *SeaCobra*. The additional weight of the TOW system (530 lbs.) would serve to negate much of the anticipated performance gain. But the pressure was strong, and on November 29, 1974 the Office of the Secretary of Defense directed the Corps to mount TOW on the *SeaCobras*. In addition, Congress made it clear that it would not appropriate the necessary dollars to fund the production of the proposed AH-1T Improved *SeaCobra* unless TOW armament was part of the package.

Several high level meetings ensued before the Marine Commandant finally was successful in obtaining a compromise plan: approximately one-half of the proposed marine buy of 55 AH-Ts would be TOW-equipped, whereas the remaining aircraft were to receive only the necessary structural modifications, i.e., reinforced bulkheads, strengthened wings, etc., to make them TOW compatible in the event that a retrofit program was authorized later. (As it turned out, the Marines received a total of 57 AH-1Ts, including the two remanufactured AH-1J prototypes; the first 33 aircraft were procured as "basic" or "slick" Ts and the final 24 had the TOW missile system added during production; the anticipated anti-armor retrofit program was begun during 1981, and by December 1983 all "slicks" had been converted; the Corps currently has 43 AH-1Ts in its inventory.)

Having resolved the TOW armament issue, the Marine Corps was given the go-ahead to order its new AH-1T Improved *SeaCobra* into production, and during June 1975 an order was placed for the first 10 aircraft. Because of the compromise plan, the Marines directed Bell to build the first prototype T Model (the remanufactured AH-1J, BuNo. 159228) as a "slick" T, but TOW-convertible. The second prototype (BuNo. 159229) was to be remanufactured in the full-up TOW configuration. Almost immediately the project ran into trouble. TOW-related modifications combined with the weight of new ECM equipment created a serious center of gravity problem. The only way to solve it was to "stretch" the fuselage by severing the aircraft aft of the cockpit bulkhead and adding a 12 in. bay (this area was fitted subsequently with fuel cells, increasing the aircraft's fuel capacity by a welcomed 14%). The new ship was finished off by adding a distinctive ventral fin to improve its directional stability.

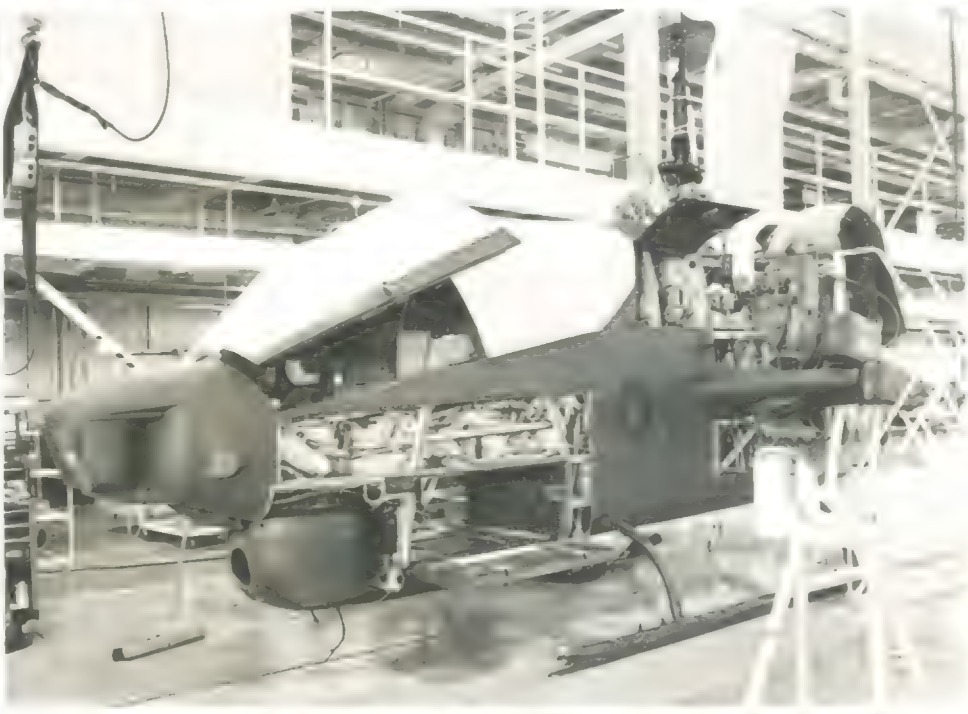
The remanufactured AH-1T prototype (BuNo. 159228) was flown for the first time on May 20, 1976 by Bell test pilots Gene Colvin and Bob Walker. Following completion of the second prototype (BuNo. 159229), both aircraft were turned over to the Corps for further testing and evaluation. The Marines liked what they saw. With its gross weight increased to 14,000 lbs., the Improved *SeaCobra* was capable of lifting more than twice (5,400 lbs.) the fuel and external ordinance of its AH-1J predecessor. While the additional weight of the TOW system meant reduced armament payloads in hot and high environments, the new 1,970 shp -402 powerplant offered significantly improved performance at all other altitudes and temperatures.

The first production AH-1T Improved *SeaCobra* was delivered to the Marine Corps by Bell's Senior Vice President of Marketing, Leonard M. "Jack" Horner on October 15, 1977. The presentation ceremonies took place during the annual convention of the Marine Corps Aviation Association held in Dallas. Accepting the aircraft (BuNo. 160105) was the Deputy Chief of Staff for Aviation, Lt. Gen. Thomas H. Miller.

With the exception of its longer fuselage, re-positioned tail rotor and ventral fin, the new AH-1T was similar externally to the AH-1J. The new aircraft retained the AH-1J's 20mm GTK4A/A turret system and four wing stores hardpoints, and although the first production ship sported a new pair of GPU-2A 20mm machine gun pods with a 300 round capacity each, other external ordnance remained the same, e.g., LAU-61, -68 and -69 rocket pods, SUU-11A 7.62mm minigun pods, SUU-44 flare dispensers, CBU-55 bombs, etc. Communications gear, pilot and copilot/gunner sighting systems and navigation aids were also essentially unchanged from the earlier AH-1J. The first AH-1T was delivered sans TOW armament; and hence, lacked the nose-mounted optical system necessary for firing the TOW missiles.

As the Marines continued to test and evaluate their new AH-1T, the gunship proved to be everything they had asked for. Pilots liked to fly it and mechanics liked to crew it. Through fifteen months of testing, it proved to be the first helicopter to actually surpass contracted reliability and maintainability requirements, scoring 100% in mission reliability and turnaround downtime and demonstrating the need for only 0.0225 manhours of corrective maintenance per flight hour at organizational level. And, during 40 mission hours flown by Bell and Marine Corps crews, there were no mission-critical component failures experienced. Additionally, a phenomenal 1.34 minutes of unscheduled maintenance was required for each flight hour. The aviators and crew chiefs were particularly impressed with the new 745 lb. T400-WV-402 powerplant. Material and aerodynamic improvements (principally aimed at turbine nozzle guide vanes and blades) to the basic T400-CP-400 *Twin Pac* had resulted in a more powerful (1,970 shp) engine that was both reliable and relatively maintenance free. Designated PT6T-6 by Pratt & Whitney, the new -402 powerplant demonstrated a significantly improved fuel consumption rate which served to increase the T Model's mission endurance.

The big change was the addition of the TOW missile system. Before the first TOW-equipped AH-1T was delivered to Marine units, extensive testing was conducted. Test firings of the TOW missiles were better than Bell expected, and gunners with little TOW experience scored as high as 90% in their target hits. During testing the missiles were fired accurately at flight speeds from hover to 140 knots with extreme agility throughout flight. The Marines may have accepted the TOW system with reservation, but it was clear that when the Corps needed to destroy hard-point targets (Marine pilots have used the


Bell Helicopter

AH-1T airframe No. 26901, undergoes disassembly during October 1987 at the beginning of its upgrade to AH-1W standard. As with other Bell Helicopter programs of this type, the upgrades are being undertaken at Bell's Amarillo, Texas facility.

Bell Helicopter

Seldom seen AH-1T "Slick", BuNo. 160105, with early nose. Thirty-three aircraft were procured by the Marine Corps without TOW capability, but eventually these were brought up to TOW standard by retrofitting the TOW nose turret.

Bell Helicopter

The prototype "SuperCobra", BuNo. 161022, was given perhaps the most stunning, yet simple, paint scheme ever seen on a military helicopter. The stylized cobra on the sides is in gold, against a gloss black background. "SuperCobra" is in white.

The first AH-1W proof-of-concept aircraft was AH-1T, BuNo. 161022. The changes, including the engine upgrade, were numerous and visually distinctive. The result, however, was one of the world's most powerful and potent combat helicopters.

weapon with good results against fortified positions) at extended ranges, the TOW's ability to penetrate made it a very effective weapon.

On December 4, 1978 the first attack helicopter squadron in the Marine Corps, HMA-269 at MCAS New River, had the distinction of receiving the first production AH-1T TOW-mounted *SeaCobra*. Again, Lt. Gen. Thomas H. Miller was a primary participant, as he and Lt. Col. K. H. Johnson, C.O. of HMA-269, flew the aircraft from Cherry Point, North Carolina to New River for the ceremonies. On hand to present the aircraft to Col. Lloyd W. Smith, Jr., commander of MAG-29, was Bell President Jim Atkins (Col. Smith had also been the C.O. of HMA-269 when the unit was first commissioned on July 1, 1971 at New River).

The principal external differences between the "slick" T and the T(TOW) was, of course, the nose-mounted TOW sighting unit and the four lightweight M65 missile launchers mounted on each stub wing. The copilot/gunner's Telescopic Sight Unit (TSU) provided the optical system necessary to aim and fire the TOW missiles and offered two optical viewing fields: 30° in the 2x magnification and 4.6° in a 13x magnification. The unit's angular coverage was ± 110° in azimuth and + 30° to − 60° in elevation and depression. A standard Hughes M65 TOW control was mounted on the right side of the TSU. The pilot was provided with a steering indicator to assist in aligning the aircraft within pre-launch constraints and maneuvering after firing. By selecting the TSU gun mode on the TOW control panel, the gunner also had the ability to fire the 20mm turret gun in the flex mode utilizing the stabilized optics of the TSU.

The AH-1T(TOW) also featured a Helmet Sight Subsystem (HSS) which permitted the pilot or copilot/gunner to rapidly acquire visible targets and to direct GTK4A/A turret fire on to those targets. The HSS consisted of two helmet sight assemblies mounted on the pilot and gunner helmets; two linkage assemblies mounted on the cockpit left canopy frame; and an electronic interface assembly located on the rear cockpit bulkhead. In operation, the linkage arm was connected to the crew member's helmet via a magnet positioned at the rear of the headgear enabling either crew member to position the turret in azimuth and elevation simply by moving their heads horizontally or vertically. The helmet-mounted sight assembly consisted of a sight eyepiece positioned in front of the right eye. A reticle image was projected by the reflex sight and appeared as a yellow/white pattern focused at the target range.

Although the AH-1T(TOW) flirted with enemy gunners in 1982 when Marine pilots launched from assault ships to aid Marines ashore in Lebanon, the real combat test came during the fall of 1983 during the American-led invasion of Grenada.

AH-1W *SuperCobra*

The Marine Corps' fourth generation AH-1W *SuperCobra* represents the present high water mark in the venerable *Cobra* line. Introduced during March 1986, the sleek new attack helicopter has been charged with providing offensive and defensive fire support for Marine Air Ground Task Force (MAGTF) operations. Its missions include escorting assault transport helicopters, providing fire support and security for ground units, conducting anti-armor and anti-helicopter operations, providing armed and visual reconnaissance, coordinating supporting arms, and even defending vital areas against fixed-wing attacks. With its enhanced performance and advanced weaponry, the awesome AH-1W promises to provide the close-in firepower needed to successfully conduct Marine air-ground operations anywhere in the world.

The AH-1W's major improvement over the AH-1T is its new twin T700-GE-401 advanced technology engines. Added to enhance hot and high performance, the combined General Electric powerplants (rated at 3,250 shp) provide a 65% increase in installed power compared to the T400-WV-402 *Twin-Pac* used in the AH-1T. To accommodate the AH-1W's increased power and gross weight (maximum of 14,750 lb.), it also has been fitted with an uprated transmission (rated at 2,030 shp) and improved drive systems, gearboxes, and rotor mast assembly. The combined engine and power train improvements translate into enhanced reliability, a significantly larger fuel and ordnance payload, and true single-engine capability. In fact, the Marines boast that on a standard day at 3,000 ft. the AH-1W can take off on a single engine and climb at better than 800 ft./min. with full fuel, 8 TOW missiles, full turret ammunition, and still have power to spare.

The AH-1W is the only attack helicopter in the world with both TOW and *Hellfire* anti-armor capability, and given the increased emphasis on anti-helicopter operations and suppression of air defense weapons, the venomous *SuperCobra* also can be armed with the air-to-air AIM-9L *Sidewinder* and AGM-122A *Sidearm* anti-radiation missiles. In addition to its complement of precision munitions, the AH-1W sports the standard 20mm gun turret and four wing-mounted weapons pylons. Each stub-wing hardpoint has a capacity of 680 lbs. and can accept 2.75-in. folding-fin or 5-in. *Zuni* air-to-ground rockets, cluster bombs, and self-contained 20mm gun pods for use against soft targets or ground fire suppression.

To enhance the aircraft's stability as a weapons platform, improve flying quality, and reduce crew fatigue, Bell has added a new vibration suppression system. It also features an upgraded avionics package, improved cockpit lighting, and a head-up display unit all designed to provide additional safety margins for the crew, particularly in the "TERF" mode. (The Marines do not talk in terms of "nap-of-the-earth", but used the terms "TERF" or "Terrain Flight". TERF conditions generally mean an altitude of 50 ft. or less and masked terrain.

The AH-1T was developed primarily to (1) solve existing AH-1T (TOW) power problems, (2) alleviate an existing attack helicopter shortfall in both active and reserve Marine squadrons, and (3) to provide the Corps with improved anti-armor and hot and high capability necessary to carry out its mission against the traditional Warsaw Pact threat in Europe as well as meet its commitment to protect U.S. interests as part of the Rapid Deployment Force.

As noted elsewhere, the addition of the required 530 lb. TOW anti-armor system created serious performance problems for the AH-1T Improved *SeaCobra*. Even before

the Marines ordered their first 10 AH-1Ts during June 1975, Pratt & Whitney already had approached them with a plan to upgrade further the newly developed -402 powerplant. Likewise, the team of Bell Helicopter and General Electric proposed integration of GE's new T700 engine into the AH-1T airframe. Unfortunately, the Marine Corps had no funds to expend on such R & D efforts.

The severity of the T (TOW) power problem can be well illustrated. Fitted with the standard 1,970 shp -402 powerplant, the AH-1T can carry 1,000 lbs. of ordnance at sea level on a standard hot day (91.5°F). At higher elevations such as 2,000 ft. as might be expected in the mountainous terrain of Central America or parts of the Persian Gulf region, the Improved *SeaCobra* is only capable of lifting a 200 lb. payload (approximately half of its full complement of 750 rounds of 20mm ammunition). At even higher elevations, again at 91.5°F, 200 lbs. of fuel would have to be downloaded before a single bullet could be put on the aircraft. Furthermore, the helicopter must be able to hover out of ground effect (HOGE) in order to fire its TOW missiles. Yet, on a standard hot day at 3,000 ft. (a situation common to many Middle East contingency areas), the AH-1T is incapable of hovering out of ground effect with a full load of fuel and zero ordnance.

By 1978, an operational requirement for an improved AH-1T powerplant had been drafted by Naval Air Systems Command, and a budget line was established for the procurement of new AH-1Ts with improved engines as well as an engine retrofit plan for existing AH-1Ts. The Marines again were disappointed when no R & D funds were provided for the program. Fortunately, Bell came to the Corps' assistance by offering to support, with company R & D funds, a feasibility demonstration involving the integration of two General Electric T700 engines and its own 2,350 shp combining gearbox from the Model 214ST into an AH-1T airframe. The Marines quickly accepted the contractor's offer and bailed a standard AH-1T back to Bell during November 1979 for the proposed modifications.

The General Electric T700 engine had been under development in various forms since 1973. The baseline powerplant, known as the T700-GE-700, had been used to power the Sikorsky YUH-60A and Boeing Vertol YUH-61A prototypes built for the Army's Utility Tactical Transport Aircraft System (UTTAS) competition during 1974, and the same powerplant was chosen during 1975 to power the Bell (YAH-63) and Hughes (YAH-64) machines entered in the AAH fly-off competition. The U.S. Army subsequently selected a T700 variant to power all production AH-64 *Apaches* under the designation T700-GE-701.

During the late 1970s General Electric engineers developed an uprated "marinized" version of the T700 engine for the U.S. Navy's so-called LAMPS (Light Airborne Multi-Purpose System) advanced ship-based SH-60B *Seahawk* helicopter. The new engine, designated the T700-GE-401, provided a 10% power upgrade over the original T700 and was optimized to withstand the corrosive maritime environment. The Navy later opted to use the navalized -401 to replace the original T58-GE-8F engines in several of its older Kaman SH-2F *Seasprites*.

Consequently, the T700-GE-401 seemed to be a natural choice for installation in the Corps' AH-1Ts. The new engines could provide the AH-1T with up to 3,400 shp, a Navy logistics support system already was in place, and the "off-the-shelf" powerplant already had demonstrated an exceptional reliability and maintainability record. When fitted with the 2,350 shp combining gearbox and an improved version of the existing AH-1T transmission, the -401 engines would allow the AH-1T airframe to hover-out-of-ground-effect (HOGE) at 3,000 ft. on a 91.5°F day with a full load of fuel and nearly a ton of ordnance. Bell test pilots Dick Kjellander and Jim Arnold flew the re-engined AH-1T for the first time during April 1980, and after extensive testing at the Fort Worth plant, the aircraft was turned over to NAVAIR for service evaluation during October 1980.

The Navy's evaluation of the -401 equipped *SeaCobra* produced good results. The aircraft demonstrated excellent single engine capability, improved hover capabilities both in and out of ground effect, increased speed, a 30% improvement in rate of climb, and a significantly enhanced fuel consumption rate. Bell quickly proffered a firm fixed-price proposal to integrate and qualify the General Electric engine in the AH-1T, but NAVAIR reluctantly rejected the offer during early 1981 as no funding was available for such a project. Hence, the Navy directed Bell to return the re-engined AH-1T to its original configuration.

By 1982 the situation had become even more aggravated. Growing attrition in attack helicopter assets, as well as the AH-1T's inability to operate effectively in hot and high environments, strained the Corps' capability to meet its Rapid Deployment Force obligations. Consequently, the Marines went before Congress to request \$17.2 million in advanced procurement funds for 22 new AH-1Ts re-engined with the GE-401 powerplants. On September 23, 1982 the Corps learned that the Senate Defense Appropriations Committee had turned down its funding request. Likewise, the House Committee also denied the advanced funding on December 2, 1982, but the FY 83 House Bill did direct the Navy to develop and qualify the T700 engine in time to be included in a proposed buy of 44 AH-1Ts scheduled for FY 84-85.

Following the House action during December, Bell and General Electric sent a joint letter to Secretary of the Navy John Lehman in which they tendered a firm fixed-price offer to build 44 new T700-powered *SeaCobras* for a development and qualification price of \$15.2 million. Bell further guaranteed that each aircraft would have a flyaway cost not to exceed \$7.1 million. On May 18, 1983, Lehman sent a memo to the Chief of Naval Operations directing him to procure the 44 Marine *SeaCobras* and to authorize the re-programming of RDT&E funds to ensure that the T700/AH-1T airframe integration efforts proceeded on schedule. The Navy responded by including in its FY 85 budget request the necessary funds to buy 22 AH-1Ts in FY 85 and another 22 in FY 86. Deliveries were to take place during FY 86-87.

On June 26, 1983, the firm fixed-price development and qualification contract was signed with Bell Helicopter Textron, and an operational AH-1T (BuNo. 161022) was bailed to the Fort Worth contractor for modification as a developmental test aircraft. Just five months later, on November 16, 1983, the re-manufactured *SuperCobra* (then known as the AH-1T+) successfully completed its maiden flight from Fort Worth with Bell test pilots Dick Kjellander and Monte Nelson aboard.

One month later, on December 15, 1983, pilots from the Naval Air Test Center at Patuxent River arrived in Texas to put the re-engined *SeaCobra* through its initial trials. The limited evaluation, known as Development Test IIB, consisted of fifteen flights totaling 17.5 flight test hours. While some deficiencies were noted, the test pilots

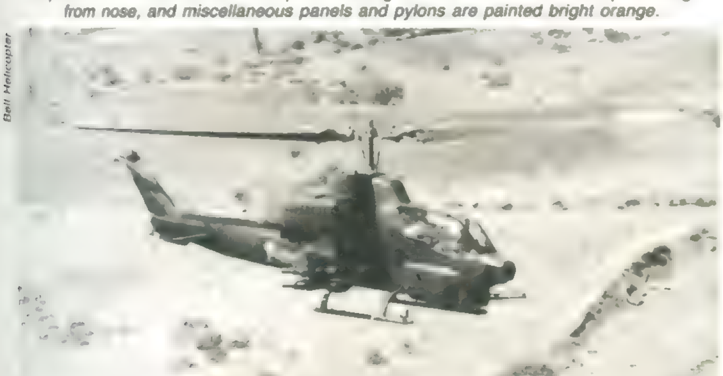
Bell Helicopter

Following its unveiling and the release of initial publicity photos, BuNo. 161022 was repainted in standard Marine Corps camouflage. Test boom can be seen protruding from nose, and miscellaneous panels and pylons are painted bright orange.

Bell Helicopter

The AH-1W has been cleared to carry and fire both the AIM-9L and AIM-9M. In this view, the prototype "SuperCobra" carries an AIM-9L on an under-stub-wing pylon. Later versions are expected to have the AIM-9 mounted on top of the outboard pylon.

Bell Helicopter



Chaff is considered a primary countermeasures system on most current helicopters. The prototype "SuperCobra" is seen releasing chaff packages during countermeasures capabilities testing. Chaff dispensing system is mounted above each stub-wing.

Bell Helicopter

The 5" "Zuni" air-to-surface rocket (seen being fired from the "SuperCobra" prototype) offers considerably more destructive power than the ubiquitous 2.75" FFAR. However, because of the "Zuni's" size and weight, significantly fewer can be carried.

generally were impressed with the aircraft's enhanced power. At the conclusion of the testing on January 10, 1984, the Naval evaluators reported that the re-engined AH-1T "showed excellent potential to accomplish the attack mission". During the evaluation period it had achieved a top speed of 173 knots (199 mph) and demonstrated a sustained level flight speed of 168 knots (193 mph). Encouraged by the results, the Navy awarded Bell a $5.6 million advance acquisition contract on May 3, 1984 and released long lead funding for the FY 85 procurement of 22 AH-1T+ aircraft.

The second Navy Preliminary Evaluation (NPE) was carried out from May 17 to June 8, 1984. After 21.5 flight hours the Navy and Marine pilots reported that all performance guarantees had been exceeded and concluded that the prototype AH-1T+ was suitable for initial operational test and evaluation (IOT&E). The operational testing, Phase OT-IIA, was carried out during July 1984, culminating in NAVAIR's approval for limited production (22 aircraft). Following additional technical and operational evaluations by NAVAIR during late 1985, Bell was given the green light to manufacture a second batch of 22 new aircraft in FY 86 for FY 87 delivery to the Fleet Marine Force.

Although the initial batch of 22 gunships were intended to replace those lost through attrition, the Corps also wanted to upgrade and modernize its attack helicopter fleet by fitting the AH-1T+ with dual anti-armor systems. As early as March 13, 1980, Lt. Gen. W. J. White, Marine Corps Deputy Chief of Staff for Aviation, had started soliciting Congressional support for arming Marine gunships with the new laser-guided *Hellfire* anti-tank missile then under development for the Army's AH-64A *Apache*. Appearing several times before the Tactical Warfare Subcommittee of the Senate Armed Services Committee during 1981-82, Gen. White pressed home the need to incorporate the new missile on all Marine AH-1s. Unlike the Army, asserted White, the Marines viewed the TOW and *Hellfire* systems as compatible rather than competitive.

On July 1, 1982, Lt. Gen. William H. Fitch succeeded White as Deputy Chief of Staff (Aviation). Gen. Fitch took up where his predecessor had left off, arguing extensively for the need to include *Hellfire* missiles as part of the AH-1T's weapon complement. The wire-guided TOW was a good weapon, he contended, and could be used under a variety of circumstances, but the Corps also needed the fire-and-forget capabilities of *Hellfire* to successfully engage heavy armor at stand-off ranges. Thanks to Fitch, the Marine Corps got its *Hellfire* missiles.

The standard TOW armament allows Marine pilots to attack light armor, personnel carriers and lightly fortified bunkers at a distance of over two miles. The precision laser-guided Rockwell *Hellfire*, with a warhead capable of defeating all known armor, can be employed against advanced armor and hard fortifications from a range at least twice that of current TOW missiles (maximum engagement range of the *Hellfire* is classified). The 98.5 lb. *Hellfire* missile actually is fired in what the Marines term the "cooperative mode", i.e., with the target laser-spotted by ground-based or airborne designators (the *SuperCobra* is not currently equipped with an on-board laser designator). Once the target has been laser-illuminated, the missile can be fired in a direct line-of-sight to the target by simply locking-on to the laser marking spot. Also, the *Hellfire's* lock-on-after-launch capability permits the aircraft to fire from a masked or hidden position, increasing mission flexibility and aircraft and crew survival. The *SuperCobra* can lift a lethal load of eight TOW or *Hellfire* or a mixed load of four each.

In order to employ a dual anti-armor system, the *SuperCobra* needed a weapons-control panel that could integrate the functions of both TOW and *Hellfire*. Canadian Marconi came to the rescue by adapting an existing *Hellfire* controller to meet the Corps' needs. The resultant design is a small (five-inch) square cathode ray tube display called THCDS (TOW/*Hellfire* Control and Display Subsystem). Thanks to Canadian Marconi's ingenuity, the Marines got their required weapons-control panel without spending a single penny for its development.

The Corps also wanted their new *SuperCobra* to have air-to-air capability to counter the growing Soviet attack helicopter threat. During 1982 the Navy successfully test fired the AIM-9L air-to-air missile against both rotary-wing and fixed-wing drone targets during helicopter air-to-air demonstration trials at the China Lake, California Weapons Center. As a result of the testing, the Marines insisted that their new AH-1T+ be qualified to carry the *Sidewinder* on its under-wing pylons. Due to budget constraints, however, *SuperCobras* thus far have been delivered sans *Sidewinders*. Although the Marines have the AIM-9L in their munitions inventory, the missile is now out of production. Consequently, it is expected that the new *SuperCobra* eventually will be armed with the improved AIM-9M missile.

The *SuperCobra* also is able to accept the Motorola-developed AGM-122A *Sidearm* missile which was introduced into the Fleet Marine Force during 1987. The lightweight anti-radiation *Sidearm*, a derivative of the AIM-9C air-to-air missile, is designed to home-in on enemy air defense radars and is intended for use against frontal air defense weapons opposing a Marine Air Group Task Force. The Marines also have indicated a need to qualify the popular *Stinger* missile on the *SuperCobra*. Although it lacks the range of the *Sidewinder*, the Corps believes that the low-cost, air-to-air heat-seeking *Stinger* can be an effective weapon in a close quarters "dogfight" with an opposing enemy helicopter. Finally, the Marine Corps is seeking a design improvement that would increase the *SuperCobra's* missile-carrying capability. Because air-to-air missiles must now be carried on the aircraft's under-wing pylons, the helicopter must be configured for all-attack or all-air-to-air missions. To increase the *SuperCobra's* versatility, the Marines hope to add a third weapons station to each wing-tip that would be strictly used for missile armament.

The *SuperCobra's* A/A49E-7(V4) turret and three-barrel 20mm gun also have recently been qualified to fire the Navy's high-velocity Phalanx round. The advanced munition features a "heavy metal" depleted uranium (DU) tungsten-steel projectile encased in a discarding sabot sheath. The super munition reportedly has about three times the armor penetration and twice the velocity of the standard M57 20mm round. In addition, the new *SuperCobra* can accept either the new General Electric two-barrel 25mm cannon or six-barrel .50 caliber Gatling gun.

From a pilot's perspective, one of the most important technological enhancements to the new *SuperCobra's* cockpit is the Kaiser Industries head-up display unit. Adapted from the system used on the Army's advanced AH-1F Modernized *Cobra*, the head-up display (HUD) not only acts as an improved sighting system for the anti-tank *Hellfire* weapons system, but allows for off-axis firing of the helicopter's air-to-air missiles. As an added benefit, the integration of critical flight cues through the HUD helps to reduce pilot workload and significantly contributes to overall flight safety, particularly in the TERF mode. Night operation capability also has been improved with the addition of state-of-the-art filtered incandescent cockpit lighting system compatible with ANVIS third generation night vision goggles.

In addition to the increased survivability offered by two individual engines (as opposed to a *Twin-Pac* configuration), other significant improvements include crew armor sized for 7.62mm hits at 2,700 ft.; a crashworthy fuel system consisting of composite honeycomb panel cells impregnated with aluminum oxide and designed to survive 23mm shell hits, a nitrogen gas fire suppression system, and fire extinguishing inertia switch to automatically activate engine fire extinguishers under crash loads; a low infrared reflective camouflage paint scheme; and multi-threat countermeasures including dual ALE-39 chaff dispensers, an ALQ-144 IR jammer, and APR-44 continuous wave and APR-39 pulse radar warning units.

In short, the aircraft that rolled off the contractor's production line during early 1986 bears little resemblance to its Improved *SeaCobra* predecessor. Recognizing that the new gunship represented a lot more than a "T Plus", the Corps opted to re-designate it the AH-1W *SuperCobra*. The first production ship (BuNo. 162532) was delivered to the Marines at Ft. Worth on March 27, 1986. Accepting for the Corps was the "father" of the AH-1W, Col. Marvin F. Pixton, III, AH-1/OV-10 Program Manager for NAVAIR. The first and second production aircraft (BuNo. 162532/33) were delivered to Patuxent River for Navy Board of Inspection Survey (BIS) trials and training during April 1986.

On October 10, 1986 Maj. Gerald Coulson, Executive Officer of HML/A-169, and Brig. Gen. Bobby Butcher, Assistant Commander, 3rd Marine Aircraft Wing, delivered the first AH-1W (BuNo. 162535) to the Fleet Marine Force (FMF) at MCAS Camp Pendleton, California. The accepting unit, HML/A-169, Marine Air Group-39, represented the first of four reorganized, composite Marine squadrons (consisting of 12 AH-1Ws and 12 UH-1Ns) to get the new gunship. The 44 AH-1Ws procured with FY 85-86 funds now are entering the FMF at a rate of two aircraft per month. Receiving units include HML/A-169, -267, -369 and -367, all based on the West Coast. Specific aircraft custodians are as follows:

Bureau No.	A/C –	Custodian
162532	1	NATC Pax River
162533	2	NATC Pax River
162534	3	HML/A-169
162535	4	HML/A-169
162536	5	HML/A-169
162537	6	VX-5
162538	7	HML/A-169
162539	8	HML/A-169
162540	9	HML/A-169
162541	10	HML/A-169
162542	11	HML/A-169
162543	12	HML/A-169
162544	13	HML/A-169
162545	14	HML/A-267
162546	15	HML/A-267
162547	16	HML/A-267
162548	17	HML/A-169
162549	18	HML/A-169
162550	19	HML/A-267
162551	20	HML/A-267
162552	21	HML/A-267
162553	22	HML/A-267
162554	23	HML/A-267
162555	24	HML/A-267
162556	25	HML/A-267
162557	26	HML/A-267
162558	27	HML/A-267
162559	28	HML/A-369
162560	29	HML/A-369
162561	30	HML/A-369
162562	31	HML/A-369
162563	32	HML/A-369
162564	33	HML/A-369
162565	34	HML/A-369
162566	35	HML/A-369
162567	36	HML/A-369
162568	37	HML/A-369
162569	38	HML/A-369
162570	39	HML/A-367
162571	40	HML/A-367
162572	41	HML/A-369
162573	42	HML/A-367
162574	43	HML/A-367
162575	44	HML/A-367

During August 1988, the Marine Corps announced a buy of 30 new AH-1Ws at a total price of $149.6 million. The contract includes an option to buy 4 additional aircraft, thus giving the service a total of 78 AH-1Ws by the time production ends during June 1991. The new buy, designed to help the Marines sustain force levels into the mid-1990s, also will allow it to equip its training squadron (HMT-303) with the same aircraft assigned to its operational forces. This will eliminate redundancy in personnel training, provide aircraft uniformity among active squadrons (now operating -1Js, -1Ts, and -1Ws), eliminate reserve shortfalls (all -1Js will be transferred to the reserves), and reduce logistical overhead.

Under an Operational Safety and Improvement Program (OSIP), the Marine Corps plans to "Block Upgrade" its existing fleet of AH-1T Improved *SeaCobras* (projected to be 37 aircraft) to the standard AH-1W configuration during the period 1987-1990. The first AH-1T to be upgraded (BuNo. 160801) arrived at Bell's Amarillo facility during early June 1987. It is expected to be delivered back to the Corps as an AH-1W sometime during 1988. All retrofitted aircraft are slated for assignment to HML/A-269 and HML/A-167, 2nd Marine Aircraft Wing, Marine Corps Air Station (MCAS) New River, North Carolina.

At the present time the AH-1W is the only remaining attack aircraft in the Marine inventory without a true night attack system. Hence, the development and qualification of a nighttime targeting sight now has top priority around NAVAIR. The groundwork for a night targeting system (NTS) was laid during 1982 when Bell integrated a Texas Instruments forward-looking infrared (FLIR) sensor into the nose of a standard AH-1T (BuNo. 159228). The FLIR unit, similar to the one retrofitted to Marine Corps OV-10A *Broncos* during 1978 (producing the OV-10D NOS [night observation/surveillance] aircraft), featured a laser target illuminator and rangefinder. Although budget constraints precluded the Marines from progressing beyond the testing stage, Texas Instruments did invest several million dollars of its own R & D funds in the so-called "Viper" sight system in the hopes of eventually landing a Marine order. It now appears, however, that the Marines will go outside of the U.S. to secure their needed night targeting system.

During 1987 the Israeli Air Force and the Marines agreed in principle to develop and produce a night targeting system. As originally proposed, the Israeli system was to be known as C-NAS (Cobra Night Attack System). However, with the addition of *Hellfire* missiles

to the new AH-1W, the Marines made it clear that any NTS unit also would have to contain a laser designator. The resultant design, known as C-LNAS (*Cobra* Laser Night Attack System), consists of a modified M65 Telescopic Sight Unit fitted with a FLIR and laser designator. The unit is compatible with night vision goggles and features a third focal view not found in the Army's C-Nite equipment. The additional focal view gives some night navigation capability and provides an enhanced search mode for better nighttime targeting. Current plans call for C-LNAS units to be manufactured by Taman Precision Instruments, a subsidiary of the Israel Aircraft Industry (IAI), based at Lod, Israel, and actually integrated into the AH-1W airframe by Bell. The joint Israeli-Marines venture could well be a catalyst for the future Israeli buy of the *Hellfire*-equipped AH-1W.

In addition to wanting a Doppler navigation system like the ASN/128 installed in the Army's AH-1F, the Marines also have shown a good deal of interest in the Bell-developed Model 680 all-composite hingeless rotor. The totally bearingless four-blade rotor features corrosion resistant, unlimited life, composite blades (constructed of an "S" glass epoxy spar and nomex honeycomb panels covered with a fiberglass skin) and a single-piece fiberglass yoke that replaces the dozens of bearings, pins, straps, grips and hinges used in ordinary rotors. The research rotor thus far only has flown on Bell's Model 222 aircraft, but has completed well over 600 demonstration flight hours. During testing, the new blades have enabled the demonstration aircraft to perform Split "S" maneuvers, 210-knot dives, and to carry out 2.8 g to −0.1 g maneuvers with ease. Additionally, those who have flown the trial machine (including the Marine AH-1W Program Manager Col. Marvin Pixton) have been impressed with the maneuverability, reduced vibration levels, low gust sensitivity, and exceptional handling qualities offered by the new rotor system.

According to Bell, an AH-1W fitted with the 680 rotor system would demonstrate significantly improved flying qualities. The 680 proposed design criteria for the AH-1W features a 48 ft. dia. blade of 25-in. chord that would offer some 42% more blade area and 11,000 more pounds of thrust than the standard two-blade rotor. When married to an uprated drive train (Bell proposes using a modified combining box and 2,400 shp transmission from its Model 214ST aircraft), Bell engineers promise that the 680 rotor will provide the *SuperCobra* with a 1,000 lb. plus increase in payload (to a maximum gross weight of 16,300 lbs.), 20 knots more speed (200+ knots), an improved vertical rate of climb (2,000+ ft./min.) and significantly enhanced maneuverability (0 to 3.29 gs). Additionally, the new rotor can be manually folded so as to utilize the same shipboard deck space as the current two-blade system. Current plans call for the installation of a larger version of the 680 rotor on the first AH-1T-to-AH-1W conversion aircraft (BuNo. 160801). This "proof of concept" demonstrator will be used to evaluate the 680 rotor's suitability for retrofit on all *SuperCobras*.

INTERNATIONAL *COBRAS*:

Since exporting its first AH-1G to Spain during the early 1970s, Bell has marketed successfully some 300 examples of single- and twin-engine *Cobras* to seven countries in the Mid East, Far East and Asia. Furthermore, the Japanese have to date manufactured more than two dozen AH-1S(MC)s (AH-1Fs) for its Ground Self Defense Force under a co-production deal struck with Bell during 1982. The Bell licensee in Japan expects to deliver another 50 to 55 modernized *Cobras* to the JGSDF through the mid-1990s. As of this writing, the following foreign military deliveries have been completed:

Spain

The Spanish have the distinction of being the first overseas operators of the *Cobra* and thus far the only European AH-1 customer. (At one time there was considerable speculation that the West Germans might purchase the Bell gunship as their anti-armor machine, but it does not now appear that such a sale will be consummated.)

During 1970 Spain approached the Army and Bell Helicopter regarding the lease or purchase of AH-1Gs for use by its Naval Air Service in the anti-shipping role. Permission was obtained to lease four AH-1Gs through the U.S. Military Assistance Program. The leased gunships (Ser. Nos. 71-15090 thru 71-15093) subsequently were manufactured under Army contract and delivered during 1971. Later that same year Congressional approval was given for a Foreign Military Sale (FMS) of four additional AH-1Gs (Ser. Nos. 72-21461 thru 72-21464), and these aircraft also were delivered to Spain's Arma Aérea de la Armada (Naval Air Arm) during 1972. All eight AH-1Gs were operated by the Rota-based *Escuadrilla 007*.

Spain recently returned three of the original four leased AH-1Gs (Ser. Nos. 71-15090, 15091 and 15093) to the Army (aircraft 71-15092 had been written off). These well-worn *Cobras* now are at the U.S. Army Aviation Classification Repair Activity Depot in Gulfport, Mississippi, and as previously noted the Army plans to convert them into AH-1F electrical and armament trainers.

Iran

One of the world's largest users of rotary wing aircraft, the Iranians purchased the bulk of their estimated 700-plus helicopters from either Italy (Boeing Helicopter's licensee, Meridionali) or the U.S. prior to the Shah being deposed during 1979. Between April 1974 and April 1977 the Shah authorized the purchase of 202 twin-engine AH-1Js for the Islamic Iranian Army. The export machine, sometimes referred to as the "International" AH-1J to distinguish it from the Marines' AH-1J *SeaCobra*, incorporates the dynamic components of Bell's Model 214 *Huey Plus*; namely, a larger (48 ft.) dia. main rotor and larger (8 ft. 8 in.), repositioned tail rotor. The aircraft also features the uprated T400-WV-402 *Twin-Pac* coupled powerplant rated at 1,970 shp for take off.

Bell delivered the first 140 Iranian AH-1Js with the M-197 20mm gun and standard AH-1J wing stores hardpoints (a/c 26501 thru 26640). Three of these aircraft then were modified to accept the TOW anti-armor missile system (a/c 26502, 26512 and 26584), and after successful testing and evaluation of the modified ships, the last batch of 62 AH-1Js (a/c 29001-29062) were manufactured to the full-up TOW configuration. It is unknown how many of Iran's AH-1Js remain operational as many now are believed grounded due to lack of spares and skilled maintenance. Interestingly, however, it is known that Iraq is operating some captured Iranian AH-1Js as well as several Bell 205As, 214As and Boeing Vertol CH-47Cs.

Korea

The Republic of Korea's helicopter inventory includes a variety of U.S. manufactured aircraft, including twin-engine Bell UH-1Ns and a small number of "International" AH-1Js. Following the development of the Iranian AH-1J(TOW), the Koreans placed an order for eight similarly equipped aircraft. Bell delivered the twin-engine *Cobras* (a/c 29063 thru 29070) between December 1976 and April 1977, and all examples were turned over to the ROK Army for extensive testing and evaluation. During August 1986 contracts were negotiated for the sale of AH-1Fs to Korea, but a secrecy clause included in the contracts precludes the manufacturer from disclosing delivery schedules or quantities purchased. While it has been reported the Koreans will buy in excess of 200 AH-1Fs, it is thought that the total will more likely be 40-60 aircraft. Informed sources speculate that first deliveries will begin sometime during 1988. It is believed that the driving force behind the ROK buy of the single-engine AH-1F was the desire for commonality with Army forces stationed in Korea.

Israel

America's closest ally in the Middle East also is very sensitive about disclosing its actual types and numbers of operational aircraft, but authoritative estimates place the total Israeli helicopter strength at approximately 250. The Israel Defense Force/Air Force is known to operate a mix of transports including French Aérospatiale Super Frelons (re-fitted with American powerplants), Sikorsky CH-53Ds, and Bell Model 205s and 212s. Rotary wing liaison duties are performed by some two dozen Bell Model 206s, and both Hughes 500MD/TOW Defenders and Bell AH-1 *Cobras* are employed in the gunship and anti-armor roles.

While its *Cobra* contingent cannot be precisely determined, it is known that the IDF/AF acquired at least 42 TOW/*Cobras* during the period 1977 through 1985. The first six ships purchased were former Army AH-1Gs modified to AH-1Qs (a/c 192191 thru 19296), and these aircraft have most likely been further upgraded to AH-1S standards. Bell subsequently deliverd 36 new production *Cobras* consisting of a half-dozen "upgunned" AH-1Es (a/c 21501 thru 21506) and the balance in AH-1Fs (a/c 21701 thru 21730). Some of these aircraft were used against Syrian armor in Lebanon's Bekaa Valley during 1982, and one *Cobra* (probably an AH-1E) is known to have been lost to enemy ground fire during the battle. Israeli *Cobras* also were used against PLO targets in southern Lebanon during September and October 1986.

Japan

During November 1977 Bell Helicopter Textron licensee Mitsui & Company ordered a single "upgunned" AH-1E for the Japanese Defense Agency. Ten months later, during September 1978, Mitsui placed a repeat order for a second aircraft. Both *Cobras* were procured for JDA evaluation in advance of a potential multi-ship acquisition and/or possible license-production in Japan. Bell delivered the first AH-1E (a/c 21507) during April 1979 and, after preliminary testing by Mitsui, this aircraft was turned over to the JDA for flight evaluation and full-scale operational testing during June of that year. The second *Cobra* (a/c 21508) was shipped to Mitsui for initial ground run and flight evaluation tests during May 1980.

Following an extended evaluation period by the JDA, Bell announced during late 1982 that it had reached a co-production agreement with Mitsui for the manufacture of the improved AH-1F TOW/*Cobra* in Japan. Mitsui (a holding company), in turn, licensed Fuji Heavy Industries actually to build the aircraft for the Japanese Ground Self Defense Force (Fuji had previously manufactured more than 150 UH-1B and UH-1H *Hueys*), and it was agreed that the Japanese *Cobras* would be manufactured at Fuji's Utsunomiya facility located approximately 175 miles northwest of Tokyo. In furtherance of the agreement, personnel from the Army *Cobra* Program Office visited Tokyo during 1983 and met with a Japanese Defense Agency team. As a result, a Memorandum of Understanding was signed by both parties which served to implement and support the *Cobra* co-production effort.

On July 6, 1984, the first Fuji-built AH-1F lifted off from Utsunomiya on its maiden flight; and five months later, during December 1984, the first locally-manufactured AH-1F was delivered to elements of the Japanese Ground Self Defense Force. Full operational deployment of the new aircraft began during 1985 with the formation of the Japanese Army's first anti-armor helicopter unit. Currently, about 95% of all *Cobra* components are produced locally including airframe, avionics and L-703 engine (produced under license by Kawasaki). Weapons subsystems are a mixed bag; some being supplied from the U.S. while others are built in Japan under license. By the end of 1987 Fuji had delivered 30 aircraft, and the Japanese manufacturer expects to supply a total of 85 AH-1Fs to three JGSDF anti-armor squadrons by the mid-1990s.

Jordan

The King Hussein government was given Congressional go-ahead for the purchase of the improved AH-1F *Cobra* during 1982. The contract, worth $156.8 million, called for Bell Helicopter Textron to manufacture two dozen modernized *Cobras* for use by Royal Jordanian units operating out of King Abdullah Air Base near Amman. The new gunships were intended to supplement Jordan's mix of older Aérospatiale *Alouette IIIs* (SA. 316 B/Cs) and twelve Aérospatiale/Westland SA.342K *Gazelles* purchased during 1978. The Jordanians took delivery for their first fifteen AH-1Fs (a/c 22601 thru 22615), sent by barge and re-assembled at Amman, during January 1985. The remaining nine *Cobras* (a/c 22616 thru 22624) arrived during December 1985. As of this writing, no repeat orders have been received.

Pakistan

The government of Pakistan also was successful in gaining approval to buy the AH-1F, and by mid-1986 they had acquired a total of twenty.

The Pakistan government initially ordered ten AH-1Fs during 1982, but quickly followed up on June 1, 1983 with a repeat order for ten more. The total Pakistan buy of 20 AH-1Fs was worth $147.2 million. Bell delivered the first batch of ten *Cobras* (a/c 22501 thru 22510) to the Pakistan Army during October 1984. The last ten machines (a/c 22511 thru 22520) were shipped by air and Army personnel supervised the re-assembly and systems check of these aircraft during May 1986. Further AH-1Fs are expected to be ordered for the Pakistan Army over the next few years as part of a six-year aid program that began during October 1987.

CONSTRUCTION AND SYSTEMS:

U.S. ARMY AH-1F

The AH-1F is a single-engine, two-blade, tandem seat,

Bell Helicopter

One of the most recent additions to the AH-1's armament repertoire is the Rockwell AGM-114 "Hellfire" (Helicopter Launched Fire and Forget). It was developed from the experimental North American AGM-64A "Hornet" missile abandoned during March 1968, and differs primarily in being somewhat smaller and significantly more capable.

Bell Helicopter

Five AH-1Ws and a single "Modernized" AH-1S await delivery from Bell's Ft. Worth, Texas facility to their respective services. Distinctive green, light gray, dark gray Marine Corps camouflage is presently peculiar to the AH-1W. All five AH-1Ws are equipped with TOW launchers on their stub-wing pylons.

two-place attack helicopter. It was developed specifically to meet the U.S. Army's need for an improved front line aerial weapon platform capable of concentrating anti-armor and area suppression fire on designated targets. The maximum gross weight for takeoff is 10,000 lbs., and the speed range of the aircraft, clean configuration, is 0 to 170 knots based on standard day conditions (29.92 in. of mercury, 15° C at sea level).

Traditional combat missions include detecting and engaging enemy armor units and other mechanized forces with covering fire for friendly units enroute to the battle area, providing flank protection for main forces, suppressing enemy personel, supporting fires or air defenses in support of tactical helilift operations; and when deployed as an economy of force with air cavalry units, deceiving, delaying, or attacking enemy units.

Airframe: The AH-1F fuselage (forward section) is of aluminum, aluminum alloy, titanium and fiberglass honeycomb panel construction. Honeycomb deck panels and bulkheads attached to two main beams produce a box-beam structure. These beams make up the primary structure and provide support for the crew compartment, wings, engine, upper pylon fairing assembly, landing gear, fuel cells and tailboom. The nose section incorporates the M65 Telescopic Sighting Unit (TSU) which is connected via braces to the fuselage main beam structure and which supports the universal turret system for positioning, sighting, ammunition feeding and firing of the M197 20mm gun.

The upper forward portion of the fuselage houses the crew compartment. Tandem armor plated seating is provided with the pilot elevated in the rear seat. The crew compartment is enclosed on the upper portion by a so-called "flat plate" canopy consisting of seven independent panels designed to attenuate glint: a three-piece windshield extends from the nose of the aircraft rearward to the pylon assembly (over the gunner and pilot heads), the gunner door and pilot window on the port side, and the gunner window and pilot door on the right side. Entrance/exit steps are located on each side of the fuselage below the canopy, and the two access doors are hinged on top and swing outward and up to provide access. The doors have gas operated struts that hold them in the full open position with a force of approximately 70 lbs.

The aircraft also is fitted with an emergency canopy removal system completely independent of the aircraft's normal electrical system. Cutting assemblies (linear explosives) mounted in the pilot and gunner doors and window frames are controlled by the pilot or gunner arming/firing mechanisms. Rotating the mechanism handle 90° counterclockwise will arm the cutting assemblies. Pulling the handle then fires a percussion primer causing the cutting assemblies to detonate. The explosive force is outward, removing the two windows and two doors simultaneously.

The forward fuselage section also is fitted with a wire strike protection system designed to protect the helicopter from wire obstructions during low level flight. The system consists of three cutter assemblies, a windshield channel and a nose deflector. An upper cutter assembly is mounted on top of the pilot station, forward of the ADF loop antenna; a chin cutter assembly is mounted under the nose just forward of the gunner station; and a lower cutter assembly is located on the fuselage, under the ammunition compartment. An assortment of antennae also are found on the fuselage including radar warning, radar countermeasures, ADF loop and sense, FM homing, radar altimeter, UHF and Doppler navigation.

Fixed cantilever wings are mounted on either side of the fuselage aft and slightly below the crew compartment. The wings have a span of 129 in. (including tip) and a mean cord of 30 in. They provide additional lift by off-loading the rotor in cruising flight and also support the wing stores pylons. Each wing has two pylons and each pylon is fitted with an ejector rack. The inboard pylons are fixed, while the outboard pylons are articulated by hydraulic activators which allow movement in elevation and depression of +7° and −5° relative to the helicopter's centerline. When not in use, the outboard pylons are returned to a stowed position of 4° above the aircraft centerline.

The tailboom (aft section) is a tapered semi-monocoque structure attached to the forward section of the fuselage by four bolts. The structure is strengthened to withstand the back pressure of a TOW missile launch and is designed to survive 12.7mm and/or 23mm cannon hits. The tailboom supports a sweptback cambered vertical fin to which the tail rotor is attached on the starboard side (14 in. from the top), tail skid, the aircraft's tail rotor drive system, and an inverted airfoil synchronized elevator positioned mid-level and toward the rear of the structure. The tailboom incorporates several avionics pieces and also serves as a mount for various antennae, including VOR, radar warning, VHF AM/FM, ADF sense, and transponder.

Landing Gear/Tail Skid: The aircraft's skid-type landing gear consists of two aluminum lateral-mounted arched crosstubes and two aluminum longitudinal skid tubes attached to the crosstubes. Each crosstube is enclosed in a fiberglass fairing for aerodynamic purposes, and each skid tube is fitted with a skid shoe on the bottom to minimize skid wear. A steel tubular-type tail skid is installed on the aft end of the tailboom to protect the tail rotor during tail-low landings.

Environmental Controls: Crew compartment ventilating, heating, and cooling are provided through an environmental control system (ECS). The system is controlled via an environmental control panel and a heat/vent air pull located in the pilot's station. The ECS is electrically controlled and engine bleed air powered. The circuit is powered by the DC nonessential bus and protected by a circuit breaker. The ECS heats/cools the crew compartment (35°F-180°F); removes moisture from the air supplied to the crew compartment; defrosts, defogs, and deices the canopy; provides rain removal (does not remove rain in flight); and provides ambient air ventilation to the crew compartment via adjustable air vents in the cockpit as well as seat cushion air controlled by a valve at the top of each seat.

Both the pitot tube and air data system (ADS) are equipped with an electrical heater controlled through the pilot's ECS control panel. Activation of the heaters in the tube and ADS sensing head prevents the accumulation of ice. The heating system is powered by the DC nonessential bus, AC system, and is protected by a circuit breaker.

An engine inlet anti-icing and de-icing system also is provided. The system consists of a hot air solenoid valve on the engine powered by DC current and protected by a circuit breaker. If ice accumulation is suspected, either crew member can activate the hot air valve to route engine bleed air to the engine air inlet. The unit is designed so that de-ice operation will become continuous if the hot air solenoid valve circuit fails or the circuit breaker becomes inoperative.

Electrical System: The AH-1F's electrical system consists of both alternating and direct current supplies. The AC power supply is the primary source and supplies 115 vac from a 10 kilovolt-ampere alternator mounted on and driven by the transmission. The alternator also can supply AC power to the transformer rectifier unit (TRU) which then can convert it to 28 vdc to power the TRU bus.

The DC system supplies power via the battery, starter-generator, alternator (via the TRU), or an external power source (GPU) through the external power receptacle located below the engine compartment on the port side of the aircraft. The battery supplies 24 vdc power when the starter-generator or other DC power sources are not in operation. The starter-generator is mounted on and driven by the engine and supplies 28 vdc power and recharges the battery.

Hydraulic System: The aircraft is fitted with a dual hydraulic system used to 1) minimize the force required by the pilot to move the cyclic, collective, and pedal controls, 2) operate the Stability and Control Augmentation System (SCAS), and 3) operate the turret and articulated wing pylons. The independent systems are installed to provide separation and to reduce the probability of a single projectile from incapacitating both systems.

The No. 1 system is located on the port side of the aircraft and provides hydraulic power to the cyclic controls, collective controls, pedal controls, and SCAS yaw controls. The No. 2 system, located on the starboard side, also provides power to the cyclic and collective controls, enables the universal turret to be traversed through varied positions in elevation and azimuth, and is used to position the outboard articulated wing pylons during TOW missile operations. An emergency hydraulic system also is provided and supplies hydraulic power to the turret, pylons, and collective pitch control should both hydraulic systems fail.

Lighting Systems: External lighting consists of two white position lights mounted on each side of the tailboom aft of the elevator and standard side navigation lighting (right side green, left side red) located on the wingtips. All four lights can be operated continuously or in a flashing mode and their brightness can be controlled from the cockpit. A flashing anti-collision light is located on top of the pylon assembly, and a retractable searchlight is positioned in a well on the underside of the fuselage aft of the turret. The searchlight can also be used as a landing light.

Internal lighting includes dimming lighting for the engine and flight instruments, avionics panels, and console panels. The aircraft's instrument panels are illuminated by built-in lights and the armament control and miscellaneous control panels are illuminated by edgelit panels. Both the pilot and gunner can activate a night vision feature which dims all interior lighting (except cockpit map and SCAS lights) to be compatible with night vision goggles. Additionally the pilot's station is fitted with two map (utility) lights and the gunner has one. Supplied in various configurations, the lights have dimming as well as red/white capabilities.

Flight Controls: The flight control system is a positive mechanical type actuated by cyclic, collective, and tail rotor controls. Complete controls are provided for both pilot and gunner, but the gunner controls are slaved to the pilot's. The control system includes cyclic, collective and anti-torque (tail rotor) controls, a force trim system, and a Stability and Control Augmentation System (SCAS).

The pilot and gunner cyclic sticks have a built-in operating friction, and both stick grips have switches for weapons firing, trim, SCAS disengagement, and communications. Cyclic control movements are not mixed, but are transmitted directly to the swashplate. Longitudinal linkage is routed through the SCAS and hydraulic boot actuators before connnecting to the right horn of the fixed swashplate ring. Lateral linkage is similarly routed to the left horn. The fore and aft movement of the cyclic also changes the synchronized elevator attitude to assist controllability and lengthen c.g. range. Control "feel" for both the cyclic and directional control systems is provided by force trim units. The system incorporates a magnetic brake and force gradient to provide artificial feel into the control systems and also serves as the means to trim the controls.

The pilot and gunner collective pitch controls are positioned on the left side of the pilot and gunner seats and control vertical flight. Stated simply, moving the collective up or down changes the angle of attack and lift developed by the main rotor, resulting in the ascent or descent of the aircraft. The collective assembly consists of a collective stick (with an adjustable friction system provided for the pilot), twist grip-type throttle with friction adjuster, and switch box assembly (pilot only). The switch box, a panel fitted at the end of the collective control, incorporates a variety of switches to operate the searchlight, jettison wing stores, increase and decrease rpm, release the idle stop and activate the ignition starter.

Anti-torque tail rotor control pedals are provided for the pilot and gunner. Pushing a pedal changes the pitch of the tail rotor resulting in directional control and is used to pivot the helicopter on its own vertical axis and trim the aircraft in flight. A pedal adjuster is provided to adjust the pedal distance for individual comfort, and heel rests are provided for the gunner to prevent inadvertent pedal operation.

Finally, a Stability and Control Augmentation System is provided. The three-axis, limited authority rate reference augmentation system cancels undesired motion during flight by inducing an electrical input into the flight control system to augment the pilot mechanical input. The SCAS control panel, located in the pilot's station, contains three channel engage switches which energize electric solenoid valves controlling hydraulic pressure to the system. The panel also contains three amber-colored NO-GO lights, one associated with each pitch, roll, and yaw channel engage switch. The lights are illuminated during the warmup period, but are locked out during SCAS engagement. Disengagement of a channel, however, restores the associated light to operation. The cyclic grip-mounted SCAS release switch is used to disengage all three channels simultaneously.

Instrumentation: Not all flight instruments, engine instruments, or other indicators are common to both crew stations. Those found only on the pilot's panel are the low airspeed indicator (LAI) to measure and display low airspeed up to 50 knots, a free air temperature indicator to display outside air temperature in degrees celsius, a horizontal situation indicator, a radar altimeter, an attitude direction indicator, a radar warning indicator, and an oil pressure/temperature indicator. Additionally, the pilot is provided with an over-torque warning light, a high-low rpm limit warning light, an engine fire warning light, and several other caution lights not included on the gunner's smaller caution panel. Those flight instruments peculiar to the gunner's station are a course indicator that receives its information from the pilot's gyro-magnetic compass set, an attitude indicator for displaying the pitch and roll attitude of the aircraft, and a magnetic compass mounted to the right side canopy frame above the gunner's instrument panel.

Instruments common to both stations include the pressure altimeter for measuring the helicopter's height above sea level in feet, a vertical speed indicator, a torquemeter (%) to display the percent of torque imposed upon the engine output shaft, tachometers for displaying engine rpm (Np rpm %)and main rotor speed (Nr rpm %), a gas producer N1 tachometer to display the rpm of the gas producer turbine speed (Ng rpm %), and a turbine gas temperature indicator (TGT degrees C x 100) to display the temperature of the air in the first stage N2 nozzle.

Avionics: The AF-1F's avionics complement consists of secure VHF-AM/FM and UHF-AM communications equipment, Doppler and homing navigational aids, a radar altimeter, an IFF receiver-transmitter, and radar and infrared countermeasures equipment. Brief descriptions of the various avionics follow.

Intercommunication System, C-6533/ARC—provides an interphone capability between the pilot and gunner. It may also be used for two-way radio communication and radio receiver monitoring.

VHF-FM Radio Set, AN/ARC-114A—is located in the gunner's instrument panel and provides two-way voice communications, with homing capability, in the frequency range of 30.00 to 75.95 MHz. Homing is primarily in the 30.00 to 60 MHz range. The FM communications antenna is located within the leading edge of the vertical fin, while the FM homing antenna is mounted on top of the fuselage just aft of the pilot's canopy.

VHF-AM Radio Set, AN/ARC-115—provides narrow band voice communications within the frequency range of 116.000 to 149.95 MHz on 1360 channels. It utilizes a blade-type antenna located on the underside of the tailboom.

UHF-AM Radio Set, AN/ARC-164 (or AN/ARC-116)—provides two-way communications within the frequency range of 225.00 to 399.95 MHz on 3500 channels for a distance of 50 miles as limited by conditions. The UHF antenna is positioned on the bottom of the fuselage underneath the engine compartment.

Direction Finder Set (ADF) RCVR AN/ARN-89B—is used in conjunction wiht the gyromagnetic compass and is interfaced with gunner's course indicator (Radio Magnetic Indicator, or RMI unit) and the pilot's Horizontal Situation Indicator (HSI). It provides automatic or manual compass bearing on any radio signal within its 100 to 3,000 KHz range. Antenna for the ADF is a loop

Bell Helicopter

BuNo. 162532 was the first actual AH-1W. After its roll-out and delivery, it was assigned immediately to VX-5 where it was utilized as a test and training aircraft. In this view, it is carrying two AGM-114 "Hellfires" and a "Zuni" rocket pod on its left stub-wing. Mounted above the latter is a chaff dispenser.

Kenneth Peoples

AH-1W, BuNo. 162534, at Nunn Airfield MCAF, Camp Pendleton, California. This aircraft is assigned to HMLA-169 and is tail-coded SN. Rotor tie-down is noteworthy, providing insight into use of skid tip eyelets. Markings are standard for AH-1W; note low-visibility national insigne on fuselage side.

Bell Helicopter

The first production AH-1W, BuNo. 162532, undergoing flight test work at Bell and immediately prior to delivery to VX-5. The AH-1W is the only attack helicopter in the U.S. military inventory with both TOW and "Hellfire" (shown) capability.

Bell Helicopter

The prototype Bell YAH-63, 73-22246, during initial October 1975 hovering trials. Two flightworthy YAH-63s and one static test airframe were built. Unlike other attack helicopters, the AH-63 differed in having the pilot in the forward position.

Bell Helicopter

The "Cobra" has been proferred to virtually every country in the free world. One of the most recent examples includes this advanced AH-1W configuration for the West Germans. Noteworthy is the four-blade rotor and air-to-air "Sidewinder" capability.

Bell Helicopter

The Iranian AH-1J differs from its Marine Corps counterpart primarily in having a larger diameter main rotor and a larger diameter tail rotor. The latter also has been repositioned to account for its size. IIAA AH-1J 3-4401 (a/c 26501) is shown.

design located just aft of the pilot's station on the top of the fuselage.

Horizontal Situation Indicator (HSI)—is used in conjunction with the ADF, VHF-FM radio in the homing mode, gyromagnetic compass, and Doppler navigation unit for range, bearing and course information.

Gyromagnetic Compass Set, AN/ASN-43—is a directional sensing system which provides an accurage visual reference indication of magnetic heading. The system is used for navigation, but may also be utilized as a free directional gyro in areas where magnetic reference is unreliable.

Doppler Navigation Set, AN/ASN-128—is a completely self-contained navigation system and does not require any ground-based aids. When used in conjunction with the AH-1F's heading and vertical reference systems, the unit provides aircraft velocity, position, and steering information from ground level to 10,000 ft. The Doppler antenna is located on the underside of the fuselage aft of the UHF antenna.

Radio Magnetic Indicator (RMI)—provides bearing information to selected radio stations relative to a magnetic heading.

Attitude Direction Indicator (ADI)—provides attitude reference and command information for the direction of flight.

Transponder Set, AN/APX-100—enables the AH-1F to identify itself automatically when properly challenged by friendly surface and airborne radar, and can be used in conjunction with KIT-1A/TSEC (classified) computer. The receiver-transmitter operates in the UHF band making the IFF unit's range dependent on altitude and limited to line of sight. The transponder antenna is located on the belly of the tailboom near the elevator.

Radar Signal Detector Set, AN/APR-39(V)1—provides the pilot with visual and audible warning when a hostile fire-control threat is encountered. The equipment can also receive missile guidance radar signals from hostile surface-to-air (SAM) missiles and their radar tracking system. Five (5) radar warning antennae are provided: two are located on either side of the fuselage nose section; two are positioned on either side of the aft section of the tailboom just forward of the vertical fin; and one

Radar Altimeter, AN/APN-209—is a short pulse, terrain tracking and altitude sensing radar system that measures and visually indicates by pointer and digital display actual clearance in feet between the helicopter and terrain over a range from 0 to 1,500 ft.

Radar Countermeasures (CM) Set, AN/ALQ-136—provides the AH-1F with protection against ground-based fire-control radars. When in operation, the equipment transmits modulating signals at radar frequencies, causing range and angle measurement errors to the radar. The equipment consists of a Receiver-Transmitter RT-1149(V)1 ALQ-136(V)1, Control Indicator C-9576/ALQ, and two antennae AS-3007/ALQ-136(V). One is used to transmit and the other to receive. The transmit antenna is located on top of the fuselage nose section in front of the gunner's windshield. The receiving antenna is mounted on top of the pylon just forward of the main rotor mast.

Infrared Countermeasures System, AN/ALQ-144—provides protection against IR threats such as heat-seeking air-to-air and surface-to-air missiles. The equipment emits a stream of modulated IR energy, using as its source of energy a cylindrical ceramic block heated by the aircraft's electrical system. The IR energy pattern produced by the unit serves to confuse hostile missile seeker systems, causing the missiles to turn away. When installed, the equipment is mounted on top of the engine exhaust suppressor.

Armament Systems: The AH-1F Modernized *Cobra's* advanced armament and fire control system makes it one of the most formidable attack helicopters in the world. The aircraft's armament subsystems are interfaced with one another and provide a high degree of attack versatility. Principal components include:

- Universal Turret Subsystem (UTS)
- Helmet Sight Subsystem (HSS)
- TOW Missile Subsystem (TMS)
- Rocket Management Subsystem (RMS)
- Fire Control Computer (FCC)
- Air Data Subsystem (ADS)
- Laser Rangefinder (LRF)
- Head-Up Display System (HUD)
- Airborne Laser Tracker (ALT)

Although some subsystems have been outlined previously, the following is a functional description of The AH-1F's integrated armament system.

Universal Turret Subsystem (UTS)—The G.E. turret system provides for positioning, sighting, ammunition feeding, and firing of the M197 20mm gun. The system consists of a turret assembly, turret control unit, logic control unit, pressure transducer, ammunition feed system with boost assembly, gun control unit, recoil assembly, slider assembly, and gun drive assembly. The turret is operated by 28 vdc and 115 vac, 400 hertz power provided by the aircraft's electrical system. It can be fired in the fixed (stowed forward) or flexible mode by the pilot through the helmet sighting subsystem, or in the flexible mode by the gunner using the helmet sight or telescopic sighting unit.

Turret travel is 220° in azimuth and 13° to 21° in elevation (depending on turret azimuth) and 50° in depression. The three-barrel M197 gun fires a burst of 16 ± 4 rounds when the cyclic trigger switch is depressed to the first detent, and fires a continuous burst at 730 ± 50 rounds per minute when the switch is pressed to the second detent. The capacity of the ammunition and feed system is 750 rounds of continuously belted ammunition. When the turret is slewed more than 5° in azimuth and an action switch is depressed to enable the firing of rockets or TOW missiles, the wing stores lockout circuitry is activated and the turret will return to the stowed (0° azimuth/0° elevation) position. Effective range of the 20mm cannon firing standard M50 series electrically primed ammunition is in excess of 2,000 meters. The following types of M50 series ammunition can be fired:

M151	20mm dummy cartridge
M53	Armor piercing incendiary cartridge
M54E2	High pressure test cartridge
M55A1 or M55A2	Target practice cartridge
M56A1 or M56A1E1 with M505 fuze	High explosive incendiary cartridge
M56A1E1 with M505A1E2 fuze	High explosive incendiary cartridge
M56A2 with M505A1 fuze	High explosive incendiary cartridge
M56A3 with M505A3 fuze	High explosive incendiary cartridge
M56A4 with M505A3 fuze	High explosive incendiary cartridge

M220	Target practice tracer cartridge
M242	High explosive incendary tracer cartridge
T221E2	Armor piercing incendiary cartridge

The turret ammunition storage unit is a three-bay, lightweight box located aft of the turret in the lower forward fuselage. It is equipped with an electrically powered booster motor and a length of flexible chuting which attaches to the cannon's delinking feeder. The booster motor eliminates excessive loads on the ammunition links which occur when the belt is pulled only by the delinking feeder.

When firing the turret using the TSU, the gunner can select either a high or low slew rate. In the high mode the TSU slews at 70° per second azimuth and 45° per second elevation. The low rate allows the TSU to slew at 4.4° per second azimuth and 3° per second elevation when high magnification is selected.

Helmet Sight Subsystem—the HSS permits the pilot or gunner to rapidly acquire visible targets and to direct the turret and/or the telescopic sight unit (TSU) to those targets. It also provides a means of cueing from pilot to gunner for target location. The system consists of two helmet sight assemblies mounted on the pilot and gunner helmets and connected by linkage assemblies to the left canopy frame. In operation, the linkage arm is connected to the crewmember's helmet by means of a magnet at the rear of the helmet. This attachment provides for quick breakaway in the event of an accident (breakaway requires approximately 20 lbs. of pull). The linkage arms enable the crewmembers to slew the turret by simply moving their heads, i.e., the gun points where the pilot or gunner looks. The helmet-mounted sight eyepiece (positioned in front of the right eye) is a reflex sight which projects a yellow/white reticle image pattern focused at the target range. Each sight (eyepiece) can be manually retracted and each linkage assembly is stowed by sliding the linkage arm into a spring loaded stow bracket at the forward end of the linkage.

TOW Missile Subsystem (TMS)—The most important weapon carried by the AH-1F *Cobra* is the M65 Airborne TOW (tube launched, optically tracked, wire-guided) missile. The rocket propelled weapon was designed for anti-armor duties, and the AH-1F is capable of carrying up to eight on its underwing pylons.

The primary TOW delivery technique, following target acquisition and lock-on, call for the AH-1S to hover in a stationary position during the firing process. High density altitude, blowing dust, and even snow, however may prevent launching from the hover.

The effective range of the TOW is from 500 to 3,750 meters. The time of flight of the TOW is determined by the distance to the target. When firing from the hover, the maximum time of flight is 21.5 seconds. Other times, based on distances, are as follows:

Meters	Seconds
3,750	21.5
3,000	15.0
2,000	8.8
1,000	4.0
500	2.0

Conveniently, the capability of the TOW to accurately destroy targets at its maximum ranges gives the aircrew a standoff advantage over many air defense systems.

The TMS utilizes optical and IR (infrared) means to track and guide the missile, and isolation from helicopter motions and vibrations is provided. Launching and guiding capabilities are provided by five functional elements of hardware packaged in eight Line Replaceable Units (LRU) mounted within the aircraft.

The telescopic sight manufactured by Hughes Aircraft is necessary for firing the TOW missile. The optical system is mounted on the nose of the helicopter and extends into the front cockpit. The sight hand control is mounted on the right side of the TSU and the left hand grip, containing the weapons-action, trigger switches and magnification controls, is mounted on the left side. The missile IR tracker and error detector are located in front of the TSU. On the bottom of the TSU relay tube (optical path) is a focus knob which will compensate for an astigmatism. Visually the unit has an angular coverage of ± 110° in azimuth and +30° to −60° in elevation. The 1,600 lb. TSU offers a 30° field of view in the 2x magnification and a 4.6° field of view in a 13x magnification. The gunner's eyepiece is monocular and can be rotated so that either eye can be used to view through the TSU. Movement of the telescopic turret (nose bucket) is accomplished by applying pressure to the sight control.

The IR tracker and error detector provide the capability of detecting the angular displacement from the optical line of sight (LOS), by tracking an IR beacon located on the aft end of the TOW missile. The direction and amplitude of the angular displacement of the missile from the TSU LOS is used to generate missile position error signals. The signals produced by the IR element are generated into FM multiplexed signals by the missile command electronic control amplifier (MCA) and transmitted over the missile command wires as commands which are used to direct the missile back to the TSU optical LOS.

The light intensity of the target is reduced about 70% when the gunner views the target through the TSU, but normally, daylight conditions are adequate to see a target at the maximum range of the TOW. Poor visibility and cloud cover reduce the range at which the target can be seen; however, if the target can be seen with the unaided eye, it can be seen through the TSU. To acquire targets at night, aircrews use flares. Gunners can acquire and engage targets by using the AN/PVS-5 night vision goggles (NVG), but the range at which the target can be acquired with goggles depends on the ambient light level. When firing TOW at night, the gunner's ability to track the target with the goggles is impaired by the light intensity of the missile motor.

The sight hand control (SHC), mounted on the right side of the TSU, contains the track stick which is a force transducer device. It provides the track commands which positions the TSU optics to enable target locating and tracking and is used to select different modes of operation for the TSU.

The TOW missile launcher (TML) provides the support and electrical interface with the M65 for up to eight (8) TOW missiles. The basic lightweight (60 lbs.) TML holds two missiles. An expansion module identical to the first TML can be mounted on the bottom of the upper TML giving the aircraft the ability to carry four missiles on each outboard station. The upper TML is supported by hooks beneath the aircraft pylon and is retained/released by rotation of the support hooks.

Rocket Management Subsystems (RMS)—The 2.75-In. (70mm) M138 rocket management subsystem in a light anti-personnel assault weapon. The basic rocket motor can be fitted with a variety of warheads including 10 and 17-lb. high explosive, dual purpose, flechette, submunition, smoke, illumination flare, and chaff. The RMS consists of a Display Unit (rockets) panel located in the pilot station and two Operations Units located in the leading edge of the wings, one for each of the inboard wing store racks (unlike the E Model which is fitted with Operations Units for all four wing stores). The RMS permits the pilot to select the desired type of 2.75-in. folding fin aerial rocket (FFAR) warhead, fuze, quantity, range, and rate.

Seven tube (M260) or nineteen tube (M261) lightweight (90 and 40 lbs. respectively) 2.75-in. rocket launchers can be mounted on the inboard and outboard wing stores racks. These launchers are reusable but nonrepairable. The required reuse is an average of 8 rockets per tube; however, development testing has resulted in as high as 64 rockets per tube.

Wing Gun Pod—The AH-1F can also be equipped with a self-contained gun pod, housing a 7.62mm machine gun, electrical system, a battery recharging system, and a maximum of 1,500 rounds of ammunition. The M18A gun is capable of firing 2,000 or 4,000 spm and the M18 can fire 4,000 spm. The pod configuration can be identified by the firing rate and heater switches on the rear of the unit. Firing control is provided via the pilot's armament control panel.

Wing Stores Jettison—Each of the four ejector racks are equipped with an electrically operated ballistic device to jettison the attached weapon during an emergency. Each device has two cartridges; the second fires automatically if the first fails to fire.

Fire Control Computer (FCC)—The Teledyne System Company manufactured fire control computer is the heart of the AH-1F's fire control subsystem. It computes data received from the telescopic sight unit, helmet sight subsystem, universal turret subsystem, rocket management subsystem, TOW missile subsystem, air data subsystem, laser rangefinder, head-up display, laser tracker, attitude reference gyro, magnetic compass, radar altimeter, torquemeter, and Doppler navigation system.

Air Data Subsystem (ADS)—The air data subsystem consists of an airspeed and direction sensor, a low airspeed indicator and an electronic processor unit which is mounted on the bulkhead aft of the pilot's seat.

Laser Rangefinder (LRF)—The LRF consists of the laser transmitter and a receiver that mount on the TSU gimbal and a laser electronics unit located above the TSU and under the fairing covering the TSU. The LRF control switches are included on the TOW control panel, and range readout is displayed through the TOW sight reticle relay tube to the gunner's eyepiece. The unit has a maximum range of 9,000 ± 20 meters and a minimum range of 200 ± 20 meters. The laser fires at four pulses per second for a maximum of five seconds. The range readout is displayed on the pilot's head-up display as well as the gunner's TSU.

Head-up Display System (HUD)—The pilot's HUD visually presents required symbology for flight and weapons firing on a partially reflective beam splitter superimposed on real world image. The primary use of the HUD is for aiming the helicopter to fire rockets and to provide the pilot steering indications for meeting the aircraft's constraints in operation of the TOW missile system. The secondary use of the HUD is for display of the engine torque, radar altitude, magnetic heading, and range for flight safety purposes when the pilot is flying head-up with eyes focused outside the cockpit. The components of the HUD are the head-up display, signal processor, and HUD boresightable mount.

Airborne Laser Tracker (ALT)—Complete provisions are provided for installation of an airborne laser tracker. The ALT is used to search out, acquire, and track targets being designated from an external laser designator. When the ALT has acquired a target the TSU can be slaved to it in order to acquire the same target.

U.S. MARINE CORPS AH-1W

The AH-1W is a tandem seat, two-place, twin-engine, armed, tactical helicopter. It is an aggressive, high speed helicopter designed and built around the fighting mission. Mission profiles cover the air-to-ground and air-to-air environment. The aircraft is maneuverable, capable of low altitude, high speed flight and self protection in hostile air and ground battle situations. Maximum gross weight for takeoff is 14,750 lbs., and the speed range of the aircraft, clean configuration, is 0 to 190 knots based on standard day conditions (29.92 in. of mercury, 15° C at sea level).

The helicopter's combat missions include anti-armor, anti-helicopter, search and target acquisition, reconnaissance by fire, multiple weapon fire support, landing zone suppression, supporting arms coordination, and troop helicopter escort. The AH-1W is capable of performing its missions from prepared or unprepared areas, during day or night flying and navigating by dead reckoning or by use of radio aids to navigation.

Airframe: The AH-1W fuselage (forward section) is similar in construction to the AH-1F described previously. It is a box-beam structure composed of aluminum, aluminum alloy, and fiberglass honeycomb panels covered with aluminum alloy skins and optimized to withstand the corrosive shipboard environment. The M65 Telescopic sighting unit (TSU) is incorporated into the nose section of the fuselage which also supports the chin-mounted A/A49E-7 (V4) turret system to position, feed and fire the helicopter's M197 20mm automatic gun.

The forward fuselage section also incorporates the tandem seat crew compartment for the pilot and co-pilot/gunner. The pilot is positioned in the rear seat and slightly elevated for maximum visibility. The pilot seat is a vertically adjustable, non-reclining type, installed at a reclined angle of 15°. A vertical height adjustment is provided on the left side of the seat, and the seat back, bottom and side panels are made of ceramic and fiberglass composite armor. Additional protection is provided by side shoulder panels which can be installed on, or removed from, the basic seat. The seat is equipped with seat and back cushions, lap safety belt, and inertia-reel shoulder harness. The co-pilot/gunner's seat is fixed, but also is installed at a reclined angle of 15°. The seat is constructed of the same ceramic and fiberglass composite armor, arm rests are provided on each side, and the seat is also equipped with a restraint system similar to that provided for the pilot.

Unlike U.S. Army *Cobras*, the AH-1W employs a more conventional rounded canopy consisting of a single-piece windshield which extends from the aircraft nose rearward to near the AN/ARN-89B ADF antenna located just forward of the upper pylon fairing assembly, the pilot canopy door and co-pilot/gunner window on the starboard side, and the pilot window and co-pilot/gunner canopy door on the port side. Although the rounded shape of the AH-1W's canopy does present a higher reflection signature, it also provides the crew with increased visibility and demonstrates reduced drag. The use of the conventional design results in a 6 knot speed improvement over the low-glint "flat-plate" configuration employed on Army *Cobras*.

Crew ingress/egress is via fixed steps located below

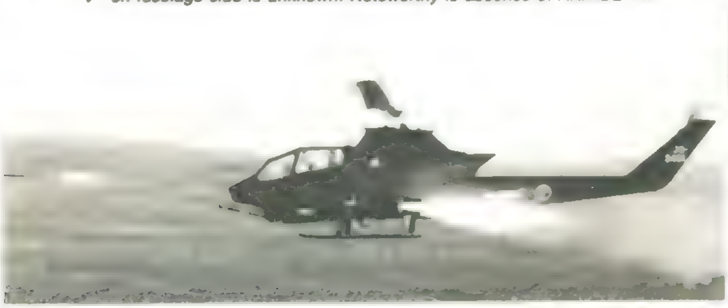
BIAF/Yehuda Borovik

Israeli Air Force AH-1S, 387, equipped with eight Hughes BGM-71 TOW missiles in stub-wing launch tubes. Camouflage is medium tan over-all. Significance of large "V" on fuselage side is unknown. Noteworthy is absence of AN/ALQ-44.

Bell Helicopter

Three Royal Jordanian Air Force AH-1Ss formate near Bell's Ft. Worth plant prior to delivery. With the exception of tail numbers (1004, 1005, and 1002, respectively), the aircraft are distinctive only due to their desert camouflage.

Bell Helicopter



The Japanese have acquired several different "Cobra" variants to accommodate Japanese Ground Self Defense Force needs. AH-1F (AH-1S "ECAS") TOW "Cobra", JG-3401 (73401), is seen firing a single 2.75" FFAR from a stub-wing mounted pod.

Bell Helicopter

AH-1F prototype for the JGSDF possibly during its first test flight from Bell's Ft. Worth facility. Turret is gunless and there is no front crew member. Extended exhaust nozzle represents initial attempt to lower exhaust infrared signature.

the canopy on the fuselage sides and two canopy access doors, one on each side of the aircraft. Both doors are opened or closed pneumatically from inside or outside by turn-type door handles. A canopy removal system provides for rapid crew egress in emergency situations. The system, similar to that employed on the AH-1F, consists of a linear explosive system, used to cut the side windows from the canopy support structure, three arm/fire manually activated percussion type detonators, and the interconnecting lines of flexible confined detonating cord. When fired, all four window cutting assemblies are immediately detonated to blow the four side windows outward in fragments, leaving empty frames for exit or access.

Space is allocated in the lower forward fuselage section aft of the gun turret for a lightweight turret ammunition storage unit, and distinctive bulges incorporated into the lower fuselage sides below the crew compartment are equipment fairings which house the AH-1W's TOW missile launching and guiding electronics. Wire strike protection also is provided, consisting of a nose deflector and deflectors and cutters installed on the upper and lower portions of the forward fuselage. the upper cutter is located on the upper pylon fairing assembly aft of the pilot station, and the lower cutter assembly is mounted on the underside of the fuselage aft of the gun turret. The forward fuselage also serves as a mount for various antennas.

Fixed cantilever wings are fitted on either side of the fuselage. They have a span of 129 in. including tip. Four wing stores attachment points are provided, two under each wing. The pylon assemblies include external store racks, sway braces and electrical connections for external stores. The entire assembly is enclosed in a fairing that matches the wing contour. As will all TOW-equipped *Cobras*, the outboard pylons are articulated to allow movement in elevation and depression relative to the aircraft's centerline.

The aft fuselage section includes a tailboom onto which a vertical stabilizer (fin) is mounted. The tailboom is of a semi-monocoque construction and is bolted to the forward fuselage section. The tail rotor assembly is positioned on the left side at the top of the vertical fin, and an inverted airfoil synchronized elevator is mounted near the aft end of the tailboom and connected by control tubes and mechanical linkage to the fore and aft cyclic control system. Antennae located on the aft fuselage include radar warning, UHF/VHF-AM and FM tactical communications, TACAN, radar altimeter, and radar beacon.

Landing Gear/Tail Skid: The skid landing gear consists of two arched aluminum crosstubes and fairings secured to the lower forward fuselage structure and two skid tubes secured to the crosstubes. Each crosstube is attached to the fuselage by a rubber pad fitting assembly. Each aluminum skid tube is fitted with steel skid shoes, mounting fixtures to attach ground handling wheels, and a tow ring at the forward end. The aircraft's steel tubular-type tail skid is attached to the lower aft section of the tailboom assembly.

Environmental Controls: Conditioned air for the crew is supplied by the environmental control unit located in the helicopter's hydraulic compartment. Either cool or warm air can be selected by a knob located on the control panel in the pilot right console.

Ventilating air is supplied through air inlets located on the leading edge of the pylon fairings, and an electrical blower provides forced air throughout the distribution system. Ventilating air is also routed through the pilot and co-pilot/gunner seat and back cushions.

Avionic and TOW electronics compartments are cooled by two blowers located under the ammunition bay floor, and a rain and ice removal system is provided for the forward window panel. Anti-icing is provided by an electrically heated bellmouth installed between each engine and the intake ducts, and hot axial compressor discharge bleed air flowing through the swirl and inlet guide vanes. In addition, hot scavenge oil flowing through internal passages in the scroll vanes provides continuous engine anti-icing.

Electrical System: Alternating current is supplied by the main and standby inverters, reference transformer and a 26 vac transfer. A static inverter supplies AC power for the aircraft's AIM-9 missile system. The main inverter provides 115 vac, 1,000 volt ampere, single-phase, 400 Hz power for operating instruments and avionics. The standby inverter supplies 115 vac, 750 volt ampere, three-phase, 400 Hz power for the TOW system and emergency AC power. The reference transformer converts 115 vac essential bus power to AC voltage settings required for armament systems, the helmet sight subsystem, and the attitude indicators. The 26 vac transformer steps down 115 vac essential bus power to 26 vac which is supplied to the 26 vac essential and non-essential bus.

Primary direct current is provided through a dual-bus, 28 volt, direct current, single-wire, negative ground arrangement. Power is supplied by two 30 volt, 400 ampere generators driven by the combining gearbox. Backup electrical power and power for starting is supplied to the electrical system by two 24 volt, 34.5 ampere hour batteries. Also, an external power receptacle is located on the left side of the fuselage.

Hydraulic System: The AH-1W is fitted with three completely independent systems: hydraulic systems No. 1 and No. 2 and the utility hydraulic system. Systems No. 1 and No. 2 are powered by two transmission driven hydraulic pumps and provide dual power boost for the main rotor controls through three hydraulic actuators (two for cyclic control and one for collective). The dual actuators are designed so that no single hydraulic leak or single pump failure will cause the loss of more than one hydraulic system. In addition to the main rotor controls, the two systems provide hydraulic power for the directional controls, SCAS actuators, rotor brake control unit, vibration suppression system, and oil cooler fan (under certain conditions). The utility hydraulic system is powered by a pump mounted on the combining gearbox. The system powers the hydraulic motor-driven fan on the transmission/combining gearbox oil cooler during normal operation.

Lighting System: External lighting consists of two white navigation lights mounted on each side of the aft portion of the tailboom and conventional side navigation lights (right side green, left side red) located on the wingtips. Five green formation lights are also provided on the tail rotor gearbox, upper pylon fairing (2), and on top of each wing tip fairing. A red flashing anti-collision light is located on top of the engine cowl, and a retractable searchlight is provided on the fuselage underside. The AH-1W is also fitted with self-powered rotor tip lights (they contain a gaseous radioisotope, tritium [hydrogen -3]) located on the top surface of each main rotor blade tip. Although non-controllable, covers are provided for masking the lights if required.

Internal lighting includes both instrument and console lighting and brightness is controlled by each crew member. Instruments are lighted by individual bezels and lighting for consoles include internal lighting and flood lights for panel lighting.

Flight Controls: The AH-1Ws dual (pilot/co-pilot) flight control system is a positive mechanical type and is essentially identical to the system described previously for the U.S. Army AH-1F aircraft. Differences do exist, however, with regard to the aircraft's throttle control system and configuration of the collective control switch box assembly.

Because the AH-1W is a twin-engine helicopter, dual twist grip throttles are provided on both pilot and co-pilot/gunner collective controls. The throttles control fuel flow to the engines via mechanical inputs through the fuel control actuators mounted on the engine hydromechanical unit (HMU). Each throttle is operated independently; the forward throttle controls engine one (port side) and the aft throttle controls engine two (starboard). An engine electrical control unit (EECU) lockout stop prevents inadvertent advancement of throttles beyond normal full open position at which point automatic fuel control function of the EECU is disabled and engine speed must be manually controlled with the throttle. In addition, mechanical linkage to engine fuel controls is provided to reduce Nr transient droop when collective is increased.

The AH-1W's pilot collective control switch box assembly contains several switches and controls not found on the AH-1F's switch box. These include a different engine start switch, an uncage/fire switch for AIM-9 missiles, a smoke release switch, and flare and chaff manual select and dispensing switches used in conjunction with the aircraft's AN/ALE-39 countermeasures dispensing system.

Vibration Suppression System: The VSS is an electronically controlled, hydraulically powered system, which automatically senses and suppresses the apparent effect of rotor-induced vibrations. The system consists of four components: accelerometer, magnetic pickup, electronic control unit, and vibration suppression assembly. The VSS is powered by hydraulic system No. 2 and controlled by a VSS switch located on the pilot's instrument panel. A nitrogen charged accumulator absorbs pressure line surges and maintains even pressure on the vibration suppressor assembly. The VSS will suppress 2/rev vibrations only between 90% and 110% rotor rpm when above 2,000 psi on hydraulic system No. 2.

Avionics: The *SuperCobra's* avionics compliment consists of various communications, navigation, and weapon systems avionics, including UHF/VHF radio sets, a voice security system (TSEC/KY-58), transponder (AN/APX-100(V)1), compass set (AN/ASN-75B), ADF (AN/ARN-89B), TACAN navigation system (AN/ARN-118(V), radar altimeter (AN/APN-194(V), radar beacon (AN/APN-154(V), FM homing, radar warning and detection systems (AN/APR-44), IR jammer, and countermeasures dispensing system.

The AN/APR-44 radar warning system is used to detect continuous wave (cw) radar signals, both ground (SAM threat) and airborne interceptor (AI), aimed at the aircraft. The system consists of four antennae, two SAM antennae are positioned on each side of the forward fuselage underbelly, and, when installed, two AI antennae are mounte din the forward section of the tailboom. Although AI radar provisions are provided, the required equipment is not normally installed in production examples, two receivers, a low pass filter, SAM/AI indicator lights (located on the AN/APR-39 indicator support bracket in the pilot cockpit and in the caution panel in the co-pilot/gunner cockpit), and a control panel. Radar detection is indicated by a tone in each crew member's headset and illumination of the SAM or AI lights.

Radar Detector System, AN/APR-39(V)1—installation and operation are identical to that previously described for the U.S. Army AH-1F. It is a passive omnidirectional radar detection system receing and displaying information to the pilot concerning the radar environment surrounding the helicopter. The equipment responds to radar signls associated with hostile fire control radar in E, F, G, H, I and J frequency bands (wide-band) and provides visual and aural indications of the presence and direction of emitters. Radar signals which are not hostile are generally excluded.

Missile guidance signals in C and D bands are also received by the APR-39. When a low-band signal is correlated with a tracking radar signal, the equipment identifies the combination as an activated SAM radar complex. The system consists of four spiral antennae (one on each side of the aft section of the tailboom and one on either side of the fuselage nose above the TOW optical system), one blade antenna (positioned on the underside of the fuselage near the main landing gear), a comparator, an APR-39 control panel, two receivers, and an APR-39 radar signal indicator.

Countermeasures System, AN/ALQ-144—is also identical to the Army AH-1F version. This active countermeasures (IR jammer) system provides mechanical modulation of radiation from an electrically heated source designed to defeat the homing of approaching hostile heat-seeking missiles. The system consists of a transmitter (mounted atop the aft portion of the upper pylon fairing assembly), an operator control unit, and a bus transfer relay assembly.

Countermeasures Dispensing System, AN/ALE-39—permits the pilot or co-pilot gunner to selectively eject flares, chaff, or active radio devices (jammers) from dispensing pods mounted vertically on the outboard portionof each wing. These items are designed to defeat enemy surveillance radar, missile guidance radar, and passive homing missiles. The system has the capability of dispensing up to sixty chaff, flare, and jammer payloads in any combination in multiples of ten and twenty. All three types of payloads can be dispensed in both manual (single) and automatic (programmed) modes independently or simultaneously. The dispensing function can be initiated by either the pilot or co-pilot/gunner.

Armament Systems: As with the AH-1F, the AH-1W *SuperCobra's* armament subsystems are interfaced with one another. Additionally, the Marine Corps *SuperCobra* is the only attack helicopter in the world with the capability to deliver both TOW and *Hellfire* missiles. Principal armament system components are:

- A/A49E-7(V4) Turret System
- Helmet Sight Subsystem (HSS)
- TOW Missile System (TMS)
- *Hellfire* Missile System (HMS)
- AIM-9 Missile System
- Wing Stores Armament System
- Head-Up Display System (HUD)

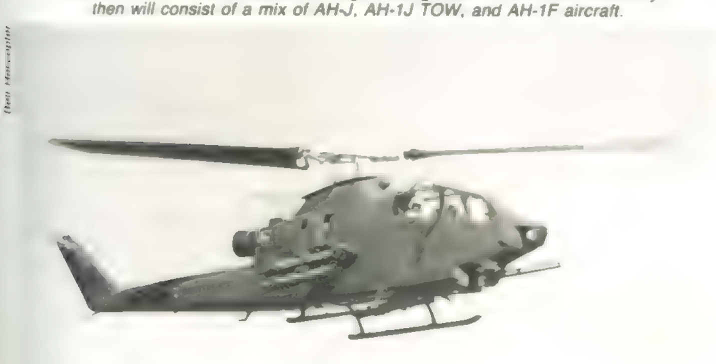
Bell Helicopter

Korean AH-1J, 29603, equipped with TOW launchers. Initial deliveries of Korean-optimized AH-1Fs are expected to begin during 1988. The Korean inventory then will consist of a mix of AH-J, AH-1J TOW, and AH-1F aircraft.

Bell Helicopter

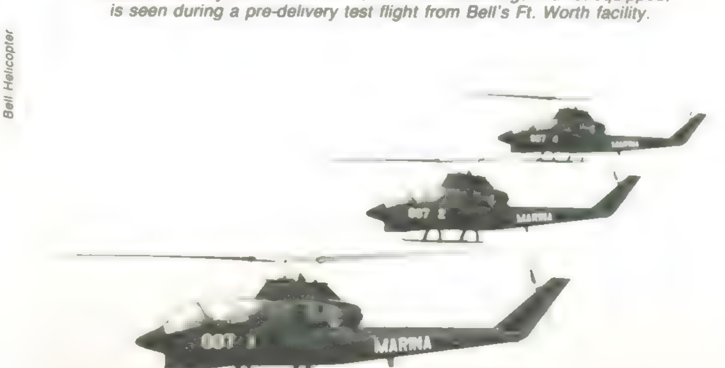
The Pakistan government has ordered an initial buy of 20 AH-1Fs for use by the Pakistani military. AH-1F, 786-007, TOW and 20mm gun turret-equipped, is seen during a pre-delivery test flight from Bell's Ft. Worth facility.

Bell Helicopter



Pakistani AH-1Fs are painted in standard U.S. Army dark, low-visibility khaki prior to delivery. Few concessions in terms of U.S. Army equipment have been made in order to accommodate the Pakistani requirement.

Bell Helicopter



Four AH-1Gs were sold to Spain and four additional aircraft were leased. Painted dark blue over-all, and referred to in-country as Z-16s, they were assigned to Escuadrilla 007. The leased aircraft since have been returned to the U.S.

Bell's Model 309 "KingCobra" laid the groundwork for the later AH-1W "SuperCobra". Two "KingCobras" were built. The first (N-309J, shown) was powered by a Pratt & Whitney T400-CP-400, and the second by a Avco-Lycoming T55-L7C.

The single-engine "KingCobra" differed markedly from its "Twin-Pac" stablemate in having a decidedly smaller engine compartment and significantly lower frontal area. Noteworthy is the extended ventral fin for improved directional stability.

One of the Model 309's lesser known features was its unusual "spiked" rotor blade tip. The design philosophy was to lower tip drag—a debilitating factor as aircraft horizontal speeds increased and rotor tip speeds began to approach sonic velocities.

A/A49E-7(V4) Turret System—The AH-1W's chin-mounted turret system provides the capability to position, feed and fire the M197 20mm gun. The turret system is interfaced wth the head-up dispaly (HUD), helmet sight subsystem (HSS), telescopic sight unit (TSU), control display subsystem (CDS), TOW/*Hellfire* Control Display Panel (THCDP) and master armament circuits. Functionally, the turret operates in a similar fashion as the universal turret fitted to the AH-1F described previously. Although the M89/M89E1 ammunition feed system also contains 750 rounds of belted ammunition, the firing rate of the AH-1W gun is approximately 80 rounds per minute slower (i.e., 650) than the AH-1F system. It is, however, also burst limited to 16 ± 4 rounds when the cyclic trigger switch is depressed to the first detent. Gun elevation, depression and azimuth ranges of both turrets are essentially the same, and the same MSO series ammunition can be used.

Helmet Sight Subsystem—The pilot and co-pilot/gunner HSS is identical to the system previously described for the AH-1F aircraft.

TOW Missile System—The *SuperCobra* employs the same TMS functional elements as those described for the AH-1F. The only significant differences are (1) the relocation of the AH-1W's TOW electronics to equipment bays on each side of the fuselage and (2) the addition of a new combined TOW/*Hellfire* Control Display Panel (THCDP) to provide the AH-1W gunner with controls and visual status indication for both anti-armor missile systems. When positioned to a TOW mode, the THCDP provides commands to the TMS for missile selection, built in test (BIT) and wire cut. The THCDS interfaces with the TMS and performs the computations and data transfers necessary for controlling the TMS. The displays appear in four major groupings: missile status, armed status, missile selection, and scratchpad display. The AH-1W aircraft also has the capability to carry two (2) or four (4) missiles on outboard wing stations 1 and 4.

Hellfire Missile System (HMS)—The HMS is capable of launching eight (8) *Hellfire* missiles at targets designated by ground or other airborne units (termed "cooperative mode" fire). This can be accomplished while the AH-1W is on the ground or airborne at airspeeds from zero to Vne.

The AGM-114A *Hellfire* is a solid propellant, laser-guided point target weapon designed to destroy armored or reinforced targets. Manufactured by the Missile Systems Division of Rockwell International, the *Hellfire* is of modular design to accommodate a variety of homing seeker heads. First production missiles are equipped with a laser semi-actively guided seeker. It guides the missile to designated targets corresponding to a coded laser spot generated by a precision designator. This gives the AH-1W crew the capability of two types of launches: lock-on-before-launch (LOBL) or lock-on-after-launch (LOAL). Launch type depends on whether the remote laser designator is fired before or after the launch of the missile. Later versions of the missile are expected to include IR, RF/IR, and millimeter wave seekers. The *Hellfire* weighs 98.5 lbs., is 64 in. long and 17 in. in diameter, and carries a 17 lb. Firestone conical-shaped-charge warhead. It can be fired in single (manual), rapid, or ripple modes, and by using a remote designator, the AH-1W never has to disclose its position to enemy radar or anti-aircraft guns during launch.

The AH-1W's HMS consists of a TOW/*Hellfire* control display system (THCDS), remote *Hellfire* electronics (RHE), multiplex remote terminal unit (MRTU), and two launchers mounted on the outboard stores position (stations 1 and 4) of each wing.

One HMS lightweight launcher is mounted on each outboard ejector rack. Each launcher can carry up to four missiles. The launchers contain internal electronics and circuitry which interfaces with the RHE, MRTU, and a special serial data bus. Arming and firing the missiles is accomplished by pilot or gunner through the HMS and wing stores armament system circuitry controls.

AIM-9 Missile System—The AIM-9 missile system is an air-to-air weapon system capable of launching *Sidewinder* missiles. The *Sidewinder* guided missile is a supersonic weapon with infrared target detection which is propelled by a solid propellant motor. The missile's launch control system consists of the cockpit control unit (CCU), an UNCAGE/FIRE switch, PRU, and the LAU-7 missile launchers.

The LAU-7 Series missile launcher provides a platform for carriage, suspension, and launching of all AIM-9 series missiles. The launcher is suspended on parent racks with the use of the pylon adapter. (The Marines hope to later equip the *SuperCobra* with a wing-tip station to avoid allocating the outboard underwing pylon to the missile.)

Wing Stores Armament System—Four attachment points are provided, two under each wing. The pylon assemblies include external store racks, sway braces and electrical connections for external stores. The entire assembly is enclosed in a fairing that matches the wing contour. The ejector rack of each pylon is equipped with an electrically operated ballistic jettison device. The jettison system consists of a breech block that utilizes cartridges with independent circuits.

The Navy Armament Control and Delivery System (NARCADS) control panel enables the pilot to program the automatic release of weapons/stores from the four wing stations in the quantity, mode, and rate selected and the gunner to select (in "Pilot Override" condition) inboard or outboard paired stations only. The system permits selective weapons/stores release by the pilot and provides capability for in-flight arming of droppable weapons. When the co-pilot/gunner activates the PILOT OVERRIDE switch located on the gunner armament control panel, he can then fire the turret and wing stores, with the exception of TOW, *Hellfire*, *Sidewinder*, and smoke grenades (although the gunner's TSU is disabled during PILOT OVERRIDE operation, the turret can be controlled by the gunner's helmet sight system).

Seven tube (LAU-68) and nineteen tube (LAU-61A/69A

lightweight 2.75-in. folding fin aerial rockets (FFAR) launchers can be mounted on each inboard and outboard ejector rack. In addition, the AH-1W can carry up to 16 of the larger 5-in. *Zuni* air-to-ground unguided rockets. For the fire-support mission, the *SuperCobra* can also accept the 595-lb. GPU-2A wing gun pod. The General Electric self-contained pod houses a 20mm gun (M197), electrical system, a 32-volt rechargable NiCad battery to power the gun barrels and breeches, 300 rounds of ammunition, and a linkless ammunition feed system. Rate of fire is 750 or 1,500 spm. Droppable stores include the 750-lb. Mod 0 and 500-lb. Mod 1 Mk 77 fire bombs and the CBU-55/B 500-lb. free-falling munition. Finally, an M-118 smoke grenade dispenser may be attached to each outboard ejector rack. Each dispenser contains two independently operated racks of six white or colored (blue, yellow, violet, red, or green) smoke grenades, 12 per dispenser. One to four grenades may be dropped at one time by the two dispensers.

Head-Up Display System (HUD)—The HUD provides the pilot visual information for flight and weapon delivery. The Kaiser Industries unit, adapted from a similar system used onthe U.S. Army AH-1F, contains a semi-reflective multilayer combiner glass which projects the HUD symbols, overlaid on the pilot's image of the real world. The symbols enable the pilot to align the helicopter for launching of the TOW, *Hellfire*, and *Sidewinder* missiles and provides a sight reticle for gun and rocket firing. Flight data presented on the HUD permits the pilot to fly without scanning tthe instrument panel for critical information. Flight data displays include engine torque, radar altitude, magnetic heading, ADF heading, TACAN heading, pitch and roll attitude, and rocket and gun reticle depression angle digital readout.

POWERPLANT, DRIVE TRAIN, AND ROTORS:

U.S. ARMY AH-1F

The AH-1F Modernized *Cobra* is powered by the 1,800 shp Avco Lycoming T53-L-703 turboshaft engine. An uprated version of the widely-used T53-L-13B, the reliable L-703 originally was developed during 1974 under the Army's Improved *Cobra* Agility and and Maneuverability (ICAM) program to enhance performance of the AH-1S (MOD) *Cobra*. The engine achieved its power growth over the L-13B powerplant through increased gas producer speed and higher operating temperatures made possible by improved air cooling of the first-stage turbine. This was accomplished by incorporating an impingement-cooled nozzle and air-cooled blades. In addition, the L-703 was fitted with a new T7 interstage turbine temperature sensor harness, giving a more accurate indication of engine internal temperature; an upgraded fuel-control system; and new materials were employed in the second-and-third-stage gas producer and power turbines.

The T53-L-703, primarily constructed of magnesium alloy, steel and titanium, is a turboshaft engine with a two-stage axial flow-free power turbine; a two-stage axial flow turbine driving a combination five-stage axial, two-stage centrifugal compressor having a nominal 8:1 compression ratio at the thermodynamic rating of 1,800 shp and incorporating compressor interstage air bleed; variable steel slator vanes; and an external annular atomizing combustor. A 3.2105:1 reduction gear housed in the air inlet housing reduces power turbine speed to output shaft speed. The engine is derated by limitation of the aircraft transmission to 100% torque for 30 minutes and 88% torque for continuous operation at 100% rpm.

Engine air induction is accomplished via a single-piece annular air intake. Ambient air enters the transmission compartment door air inlet and then is routed through the foreign object damage (FOD) screen and the particle separator to the engine air inlet. An engine inlet anti-icing/de-icing system is provided to route engine bleed air to the engine air inlet, however, the system will not de-ice or prevent icing of the FOD screen or particle separator.

The engine oil system is a dry sump, pressure type, and completely automatic. The oil tank, located in the upper pylon fairing, will self-seal a .30 caliber projectile hole and is equipped with deaeration provisions. Oil is gravity fed from tank to engine driven oil pump which provides pressure and scavenging for the system. Engine oil cooling is accomplished by an oil cooler and a bleed air driven turbine fan. The engine and transmission oil coolers use the same fan.

The AH-1F's engine compartment is cooled by ram and ambient air, and armor material is located on the left and right engine compartment doors to provide armor protection for the engine compressor, fuel control assembly, oil filter, and fuel filter.

Avco Lycoming T-53-L-703 engine specifications are:

Length overall	47.6 in.
Maximum diameter	23.0 in.
Weight (dry w/particle separator)	540 lbs.

Engine power is transmitted to the rotors via the aircraft's power train system. The power train consists of a main rotor drive system and a tail rotor drive system, along with associated gearboxes, bearing hangers, and couplings.

The transmission transfers engine power to the main rotor through the mast assembly and to the tail rotor through a series of driveshafts and gearboxes. The transmission, basically a reduction gearbox used to transmit engine power at a reduced rpm to the rotor system, is mounted forward of the engine and coupled to the power turbine shaft at the cool end of the engine by the main driveshaft.

The AH-1F's tail rotor drive system consists of associated shafting, couplings, hangers and gearboxes. The tail rotor driveshaft actually consists of five driveshafts and three hanger bearing assemblies. The assemblies and two gearboxes connect the transmission tail rotor drive quill to the tail rotor. The aircraft's intermediate gearbox is located at the base of the vertical fin and provides a 42° change of direction of the tail rotor driveshaft. Likewise, the tail rotor gearbox is located near the top of the vertical fin and provides a 90° change of direction of the tail rotor driveshaft. Both gearboxes are provided with individual self-contained wet sump oil systems, oil level sight glasses, filler caps, and magnetic chip dectectors.

The main rotor is driven by the mast which is connected to the transmission. The rotor rpm is governed by the engine rpm during powered flight. The rotor tip path plane is controlled by the cyclic stick, and rotor pitch is controlled by the collective stick. The main rotor is a two-bladed, semi-rigid, seesaw type, forming a single assembly which is attached to the mast through a bearing-mounted trunnion and is secured with a nut. Hence, the rotor blades are permitted to rise and fall in a seesaw manner as they rotate. Each main rotor blade is attached in the rotor hub with a retaining bolt assembly and is held in alignment by adjustable drag braces. Rotor grip, yoke and extension forgings are of VAR 4340 alloy.

The K-747 blade airfoil shape is based on a family of advanced airfoils developed by Boeing Vertol. For the outer 15% of the blade, i.e., from $r/R = .85$ (85% blade radius station) out, the 8%-thick Boeing Vertol VR-8 airfoil is used; from $r/R = .25$ to $r/R = .67$, the 12% Boeing Vertol VR-7 airfoil is used, with a linear transition between the 67% and 85% radius stations. From $r/R = .25$ station inboard, the blade is built-up gradually by cheek-plates. The leading edge becomes blunt and reaches a maximum thickness of 25% at the root end of the blade at $r/R = .18$. The main rotor blade includes a tapered tip planform, composite material construction, and a multicell ballistically tolerant filament-wound fiberglass spar. The spar, a Nomex core afterbody, and a Kevlar trailing edge spline, are all enclosed by a distinctive "basket weave" textured fiberglass skin. At the inboard end, the cheek-plates carry blade loads to an aluminum adapter, which attaches the blade to the *Cobra's* rotor hub via the hub pin.

The composite blade has the same diameter and essentially the same solidity as the metal B-540 blade, although the blade planform is changed and the blade twist is increased. Rotor dynamic characteristics are designed to match those of the B-540, and a 53 lb. brass tip weight, integral with the spar, provides rotor inertial characteristics similar to the metal blade. Over the constant chord section of the blade, the chord is 2.5 ft.—compared to 2.25 ft. on the B-540 blade for the whole blade length. The outer 15% of the composite blade is tapered in both thickness and planform. The tip planform taper is trapezoidal and results in a tip chord of 0.83 ft. The solidity of the rotor is 0.9625, compared to 0.065 for the B-540.

The 8 ft. 6 in. tail rotor is a two-bladed, semi-rigid delta-hinge type. Each blade is connected to a common yoke by a grip and ptich change bearings. The hub and blade assembly is mounted on the tail rotor shaft with a delta-hinge trunnion to minimize rotor flapping. Blade pitch change is accomplished by movement of the anti-torque pedals which are connected to a pitch control system through the tail rotor (90°) gearbox. Blade pitch change serves to offset torque and provide heading control. Maximum operating life for the tail rotor is 2,400 hours.

U.S. Marine Corps AH-1W

The AH-1W's General Electric T700-GE-401 engines are derived from the basic T700 turboshaft powerplant developed during the 1970s for the U.S. Army's UH-60 *Blackhawk* and later adopted for use on the AH-64A *Apache*. The navalized version, first used in the Sikorsky SH-60B *Seahawk*, features improved corrosion protection and delivers some 10% more power than the original Army T700.

The T700-GE-401 engines are front-drive, turboshaft engines of modular construction. Each engine is composed of a combination axial/centrifugal six-stage compressor, an annular combustor with central fuel injectors, and a two-stage power turbine. A coaxial driveshaft extends from the power turbine forward through the gas generator turbine and compressor. The driveshaft is connected by a splined joint to the engine output shaft. The compressor has stage one and stage two variable vanes in the casing, inlet guide vanes in the mainframe, three actuating rings (one for each stage), and a starting bleed air valve to aid in efficient engine operation throughout the entire operating range. Actual engine air induction is accomplished via a bellmouth inlet at the front of the engine. An integral air inlet particle separator protects the engine from the ingestion of sand and dust.

The engine's cold section module is made up of the mainframe; diffuser; inlet particle separator; a combined axial/centrifugal stage mounted on the same shaft (each axial stage is a one-piece "blisk" [blades plus disc] in AM355 steel; inlet guide vanes are variable; pressure ratio is approximately 15:1; airflow is approximately 10 lbs./sec. at 44,720 rpm); the output shaft assembly; and other associated components including anti-icing and start bleed valve, ignition system, history recorder, and electrical control unit.

The gas generator turbine, stage one nozzle assembly, and the annular combustion liner (the flame tube is a machined ring made up of highly corrosion resistant Hastelloy X alloy) make up the so-called hot section. The power turbine section module contains the two-stage power (HP) turbine (which operates at 1,100°C; the first-stage nozzle is cast in X40 alloy and the second stage, which is cast in two-vane segments, is cast in R80 alloy) and exhaust frame, thermocouple harness, torque and overspeed sensor, and Np sensor. The discs, cooling plates, and blades of both gas generator stages are clamped in position by five short tiebolts; five large bolts then tighten the turbine to the shaft, driving the unit via a curvic joint. The rated shaft speed is 44,720 rpm.

The two-stage free power turbine, designed for high efficiency at partial power levels (especially 30% and 60% mil power), has tip shrouded blades and segmented nozzles. Power turbine inlet temperature at intermediate power is 827°C. The nozzle guide vanes are of René 77 alloy, the rotor discs are of Inco 718 alloy, and the uncooled rotor blades are of René 80 alloy. The output speed of this section varies between 17,000 and 21,000 rpm.

The -401's final section, the accessory module, which is grouped at the top of the engine, includes the accessory gearbox and several other components such as a hydro-mechanical unit, a fuel boost pump, an oil filter and cooler, an alternator, a lubrication supply tank and scavenge pump, the particle separator blower, a chip detector, and the fuel filter assembly.

Air enters the engine compartment through intake ducts located on each side of the transmission cowling. Bellmouth assemblies connect the engines to the intake ducts and air enters the engine from the bellmouth, through the engine swirl frame. The rotating or swirling motion of the incoming air created by the swirl vanes separates foreign particles from the incoming air by centrifugal action. These particles are then drawn by a blower and exhausted through a discharge duct. The clean air that remains after particle separation is carried to the deswirl vanes, which straighten the flow of air before it enters the compressor.

The fuel system of the T700-GE-401 engine consists of the main fuel manifold, fuel injectors, suction fuel boost pump, hydromechanical unit (HMU), and fuel filter. The fuel system operates in conjunction with the engine electrical control unit (EECU) to provide proper fuel flow to the engine during starting, acceleration, deceleration, and steady-state operation.

Lubrication of the engine is accomplished through a self-contained recirculating dry sump system. The in-

tegral oil tank is serviced on the right side of the engine, and a fluid level indicator is located on both sides of the oil tank. The oil is circulated through the system by a gerotor type pump. An oil scavenge system removes oil from the sumps and returns it to the oil tank. Scavenge oil is cooled by passing it through an oil cooler and transferring the heat to fuel routed through the cooler. Additional air cooling occurs as oil flows through the scroll vanes enroute to the oil tank.

General Electric T700-GE-401 engine specifications are:

Length overall	46.5 in.
Maximum diameter	25.0 in.
Weight (dry/w particle separator	427 lbs.

The transmission system transmits power from the engines to the main rotor, tail rotor, and accessories. The system includes the main rotor transmission system; a combining gearbox; tail rotor transmission system; accessory drive pads; speed, temperature and pressure sensors; and associated lubrication systems.

The main rotor transmission system consists of the main transmission, mast assembly and main input driveshaft. It is driven by the combining gearbox, through the main driveshaft, and decreases speed to the main rotor mast, rail rotor driveshaft, and transmission mounted accessories. The mast assembly transmits power from the transmission to the main rotor. The main transmission incorporates drive pads for hydraulic systems No. 1 and No. 2 pumps, rotor brake, and rotor tachometer generator.

The transmission oil system is a wet sump type consisting of a pressure pump, oil cooler, automatic emergency oil cooler bypass valve, pressure relief and regulating valves, chip detectors, and oil filters.

The transmission and combining gearbox oil cooler consists of two heat exchangers which share cooling air supplied by a hydraulic motor driven fan. During normal operation the primary fan motor is powered by the utility hydraulic system. If the utility hydraulic system, primary motor or clutch, are disabled, the secondary hydraulic motor, powered by hydraulic system No. 2, can be actuated to drive the fan.

The aircraft's 2,030 shp combining gearbox is connected to the output driveshafts of the engines. Freewheeling units installed in each input drive train allows the combining gearbox to accept power from either engine or both engines, and the combined power of both engines is transmitted to the main driveshaft through the combining gearbox at desired rotational speed. The gearbox drives two DC generators and the utility hydraulic system pump. Oil supply is contained in a gearbox sump and is circulated under pressure from the gear driven pump through internal passages and an internal screen to oil jets. Oil from the gearbox passes through an external filter (40 micron) and external lines routed to an oil cooler below the engine deck and returns through a second external filter (3 micron) to an oil port on top of the gearbox. The oil manifold distributes oil through the various tubes, passages, and jets to lubricate gears and bearings inside the gearbox.

The tail rotor transmission system consists of shaft assemblies, hanger bearing assemblies, flexible couplings, and gearboxes. Hanger bearings are installed to support the shaft sections. Grease packed couplings are used at the main transmission output drive and on the forward side of the first hanger bearing to accommodate pylon motion, and on the intermediate gearbox output drive to accommodate fin deflection. Flexible disc couplings are installed at the remaining hanger bearings, the intermediate gearbox input quill, and the tail rotor gearbox input quill to accommodate tailboom deflections. A fan is mounted on the intermediate gearbox output coupling to provide cooling for the gearbox.

The intermediate gearbox, located at the base of the vertical fin, provides a 42° change of direction of the tail rotor driveshaft. The tail rotor gearbox, located at the top of the vertical fin, provides a 90° change of direction of the tail rotor driveshaft and reduces the driveshaft input speed of 4,452 rpm to 1,460 tail rotor rpm. Both gearboxes are provided with individual self-contained wet sump oil systems, oil level sight glasses, filler caps, and magnetic chip detectors.

The main rotor hub and blade assembly is a two bladed, semi-rigid seesaw type with preconing and underslinging to optimize dynamic stability. It consists of a metal, bonded blade made from extruded aluminum spars and laminates attached to each grip and spindle assembly which, in turn is attached to a common yoke assembly. The grip and spindle assembly is the pitch change element and is composed of oil lubricated roller bearings, elastomeric oil seals, tension torsion straps, strap pins and fittings, spindle, grip drag brace, and pitch horn. The yoke assembly consists of a flex beam yoke, with a trunnion and elasomeric bearings mounted in the center section to form the flapping axis 90° to the pitch change axis.

The main rotor control system consists of a swashplate mounted on a spherical surface for cyclic input, a sleeve for collective input and scissors levers mounted on the sleeve assembly hub for mixing these motions. Pitch change links are attached between each scissor lever and rotor pitch horn for collective and cyclic control.

For safe shipboard operation, the AH-1W is fitted with a rotor brake.

The tail rotor hub and blade assembly is of similar design as the main rotor, i.e., a two-bladed, semi-rigid rotor with a skewed flapping axis with preconing and underslinging. Tail rotor diameter is 9 ft. 9 in. The tail rotor hub and blade assembly consists of a metal blade attached to grip plates by bolts. The grip plates are mounted on a common flex beam yoke by a spherical pitch change bearing. A split trunnion is mounted on the yoke center section by spherical flapping bearings.

The tail rotor control system consists of a fixed control system to the pitch change control tube. The control tube extends through the tail rotor gearbox and is attached to the crosshead. Pitch change links connect the crosshead and pitch horns for pitch changes resulting from anti-torque pedal movement. An active counterbalance system, activated by pitch change, offsets the blades restoring moment, resulting in the ability to fly boost-off if the requirement should occur.

Bell Helicopter

Little-known AH-1G test program involved the installation of an electrically foldable main rotor. The study was conducted for a variety of reasons, including aircraft stowability, but complexity, reliability, and cost factors killed it.

JAH-1G, 71-20985 with experimental GE M179 20mm gun installation offering an increased firing rate (from 750 rpm to 1,500 rpm). The nose mounted a Bell stabilized optical sight on the left and a Hughes laser rangefinder on the right.

Bell Helicopter

The NASA conducted an engineering study calling for the modification of an AH-1G testbed to V-tail configuration. Stability improvements were thought possible. Note that the tail rotor would be retained on the right half of the V-tail.

The Model 249 has served as a testbed for a number of "Cobra" related programs including the Model 412/four blade rotor (shown), and the newer Advanced Rotorcraft Technology Integration (ARTI) and Advanced Capability (ADCAP) programs.

Bob MacArthur

AH-1G, 69-16440, at Elmendorf AFB, Alaska on August 17, 1975. It bears the specialized, extremely colorful markings of cold weather environment-assigned aircraft. Visible suspended from the right stub-wing inboard pylon is an M18 "Minigun" pod containing a single 7.65mm six barrel rotary gun. Ammunition for this gun is stowed in the removable magazine attached to the landing gear legs, next to the fuselage. Yellow, black, and red pod markings are noteworthy.

Jay Miller/Aerofax, Inc

Bell AH-1G, 66-15273, of D Troop, 6th Squadron, during a transient stopover at Mueller Airport, Austin, Texas. M28 turret is weaponless, but stub-wings each are carrying two 19-tube FFAR pods. Barely visible aft of the turret is the not-often-seen-extended landing light. This small unit retracts aft into a small recess under the forward cockpit. AH-1G nose turret normally was equipped with an M129 grenade launcher and a 7.62mm "Minigun", or two "Miniguns".

Jay Miller/Aerofax, Inc

"International" AH-1J, 3-4474, of the Imperial Iranian Army during May 1975, and shortly before entering the Bell paint facility. A variety of metals and composites created an interesting color patchwork. "Cobras", during the height of their production program, often were flight tested in unpainted condition. Iranian AH-1Js differed little externally from their Marine Corps counterparts. A total of 202 AH-1Js eventually were sold to Iran.

Jay Miller/Aerofax, Inc

"International **AH-1J, 3-4469**, of the Imperial Iranian Army during May 1975. Iranian "Cobras", starting during 1975, were delivered with full armament, full paint, and with tail numbers and national insigne in place. Iranian "Cobras" have seen significant action during the war between Iran and Iraq. Spare parts shortages, however, have grossly affected their usefulness; available intelligence indicates that most now have been grounded.

Jay Miller/Aerofax, Inc

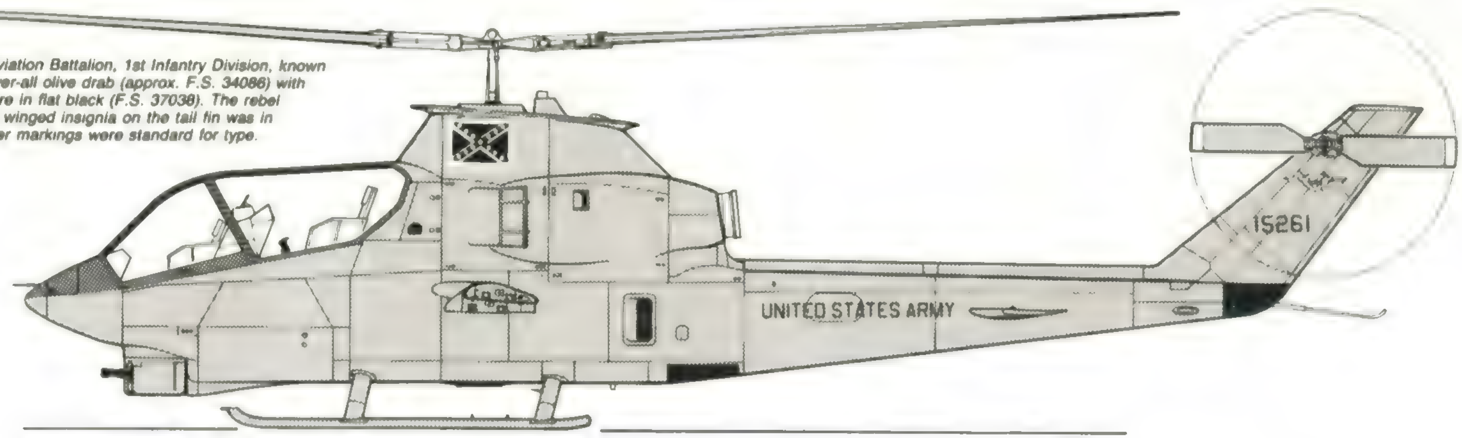
The only **YAH-1R** built, **70-15936**, during May 1975 at Bell's Arlington, Texas municipal airport flight test facility. This aircraft was part of the Improved "Cobra" Agility and Maneuverability study and, along with a single modified AH-1G, explored numerous modificaitons options including reconfigured rotor heads and composite blades. Markings were optimized for photo tracking and related purposes. Two 19-tube FFAR pods are suspended from each of the aircraft's stub-wings.

AH-1J, BuNo. 159212, at El Toro MCAS, California during June 1977. It is seen in its original, short-lived post-Vietnam era Marine Corps gloss green scheme. All-white 19-tube FFAR pods and miscellaneous full-visibility markings are noteworthy. Because of relatively serious powerplant limitations in hot and high environments, the AH-1J did not prove to be particularly popular with the Marine Corps. A requirement for more fuel and TOW capability thus led to the birth of the AH-1T.

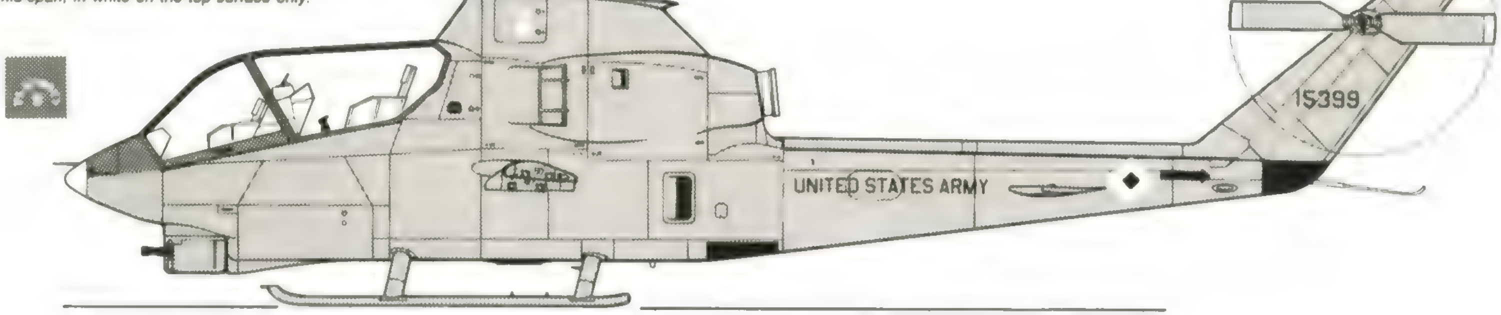
The prototype **AH-1W, BuNo. 161022**, originally was referred to by the Marine Corps as the AH-1T+. Powered by two General Electric T700 turboshaft engines with a combined installed rating of over 3,200 shp, it proved attractive enough to the Marine Corps to lead to a contract for 44 new aircraft and 37 modifications to extant AH-1Ts. An additional 30 new AH-1Ws were ordered during early August 1988, just as the last of the original 44 new aircraft was being delivered.

AH-1W, BuNo. 162536, wearing the extant Marine Corps camouflage for type, on Bell's Hurst, Texas production facility flight line during October 1986. TOW launchers are mounted on each outboard pylon of each stub-wing. A chaff dispenser is mounted on the top of each stub-wing. Low stance provides good ground stability while easing maintenance access difficulties. This model remains the high water mark for "Cobra" development as of the date of this writing.

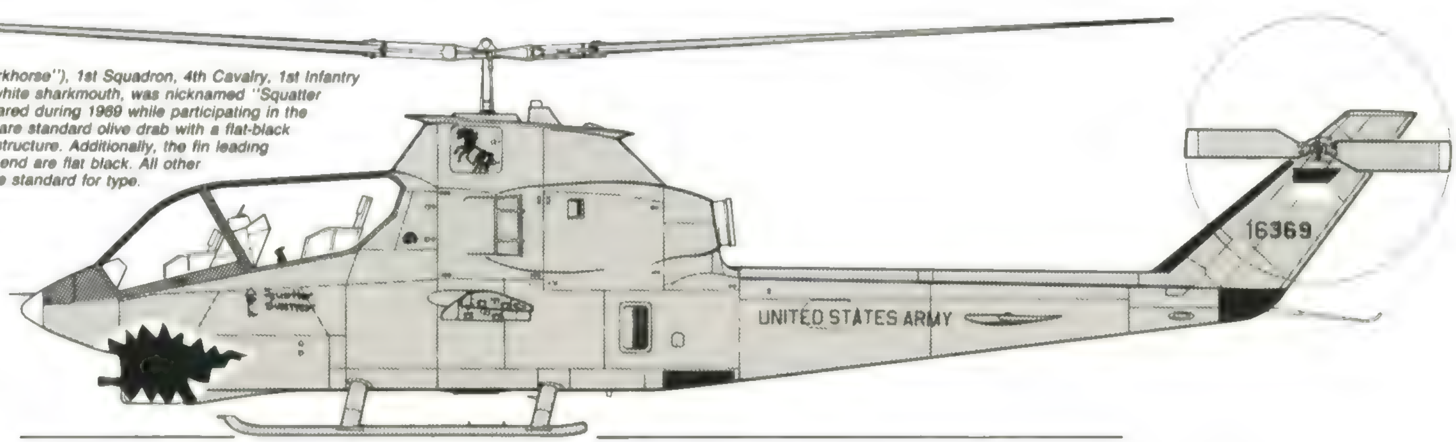
Bell AH-1G, '15261, of B Company, 1st Aviation Battalion, 1st Infantry Division, known as the "Rebels". Color was standard over-all olive drab (approx. F.S. 34086) with anti-glare panels and canopy structure in flat black (F.S. 37038). The rebel flag was in standard colors and the winged insignia on the tail fin was in silver with a black outline. All other markings were standard for type.



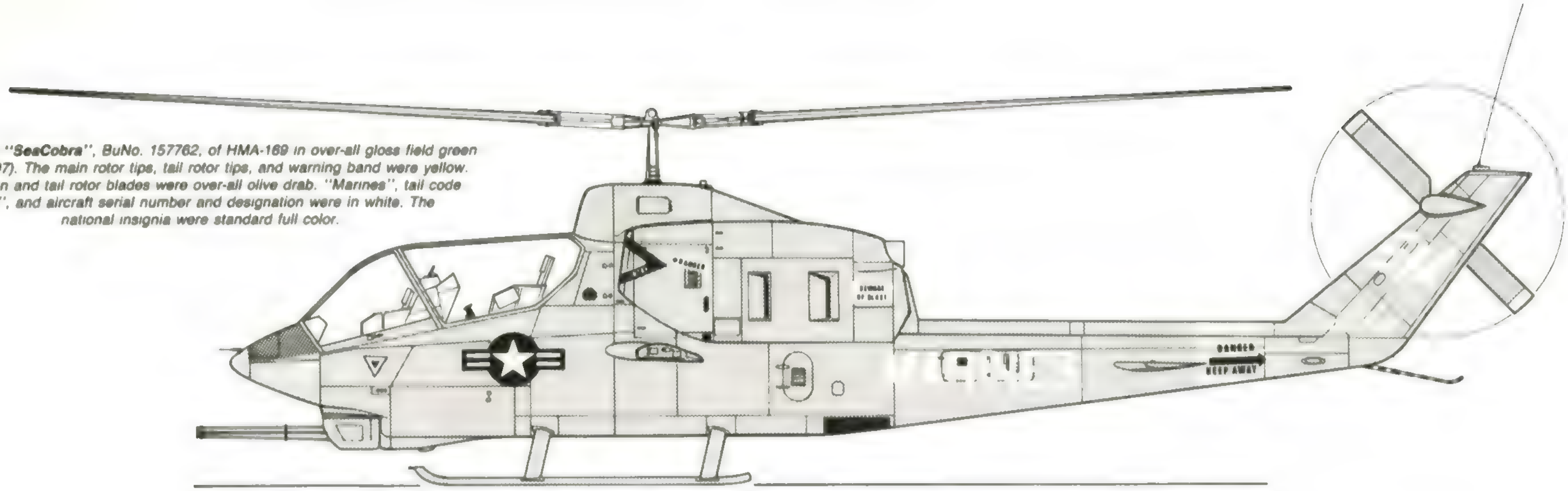
Bell AH-1G, '15399, of the 334th AHC, 2nd Platoon, 145th Combat Battalion, 12th Group. The olive drab color was standard for type. The Playboy insignia on the nose and rotor cowl were in white. The main rotor blades were in olive drab with blade bands, located at approximately mid-span, in white on the top surface only.



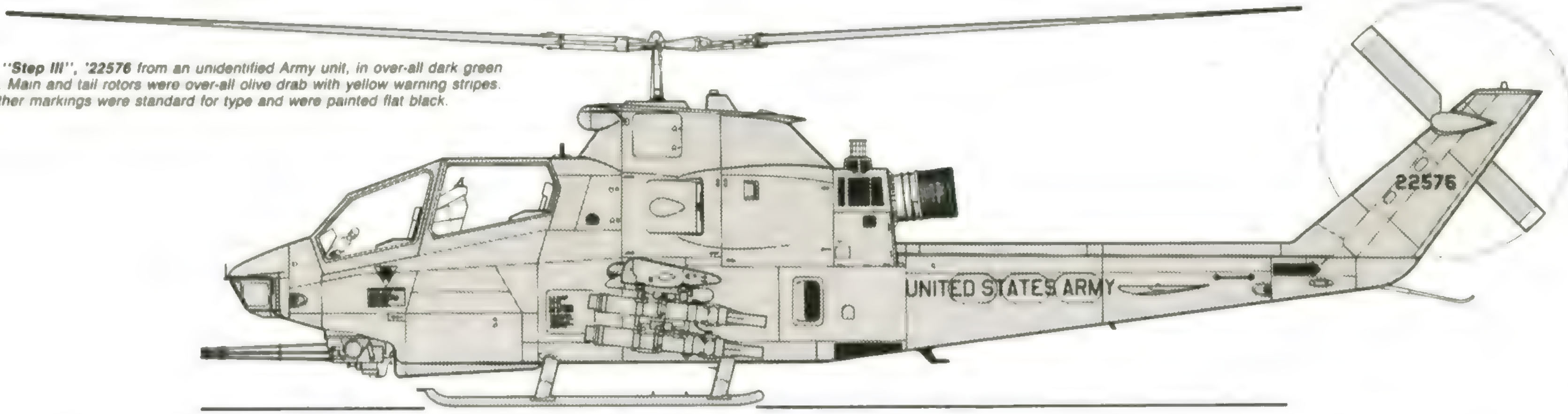
Bell AH-1G, '16369, of Delta Troop ("Darkhorse"), 1st Squadron, 4th Cavalry, 1st Infantry Division. The aircraft, with red and white sharkmouth, was nicknamed "Squatter Swatter", and is shown as it appeared during 1969 while participating in the Vietnam war. Over-all markings are standard olive drab with a flat-black anti-glare panel and canopy structure. Additionally, the fin leading edge and tail boom end are flat black. All other markings are standard for type.



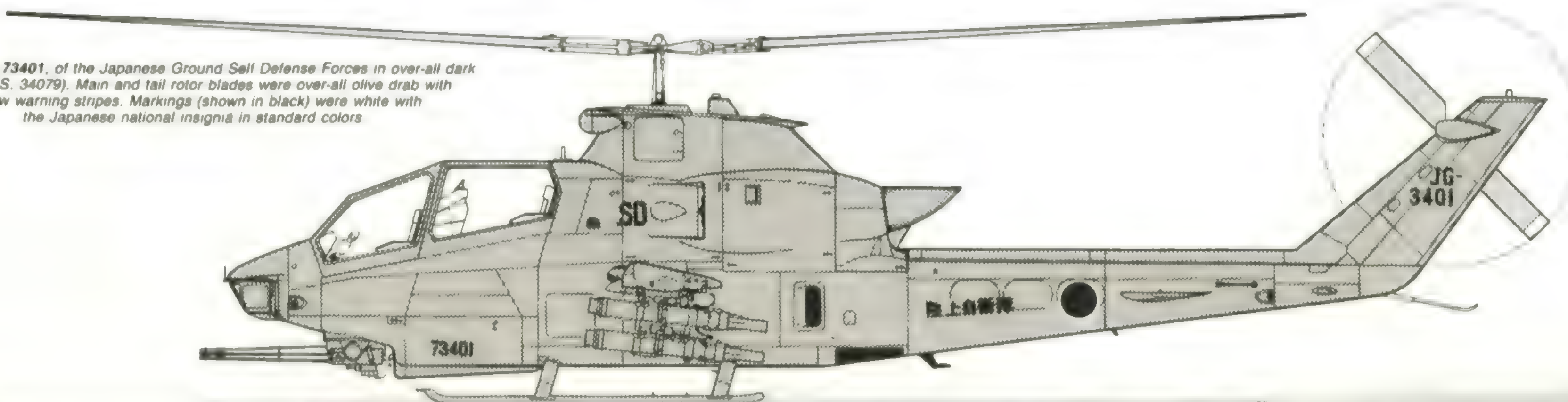
Bell AH-1J "SeaCobra", BuNo. 157762, of HMA-169 in over-all gloss field green (F.S. 14097). The main rotor tips, tail rotor tips, and warning band were yellow. Both main and tail rotor blades were over-all olive drab. "Marines", tail code "SM", and aircraft serial number and designation were in white. The national insignia were standard full color.



Bell AH-1S, "Step III", '22576 from an unidentified Army unit, in over-all dark green (F.S. 34087). Main and tail rotors were over-all olive drab with yellow warning stripes. All other markings were standard for type and were painted flat black.



Bell AH-1S, 73401, of the Japanese Ground Self Defense Forces in over-all dark green (F.S. 34079). Main and tail rotor blades were over-all olive drab with yellow warning stripes. Markings (shown in black) were white with the Japanese national insignia in standard colors



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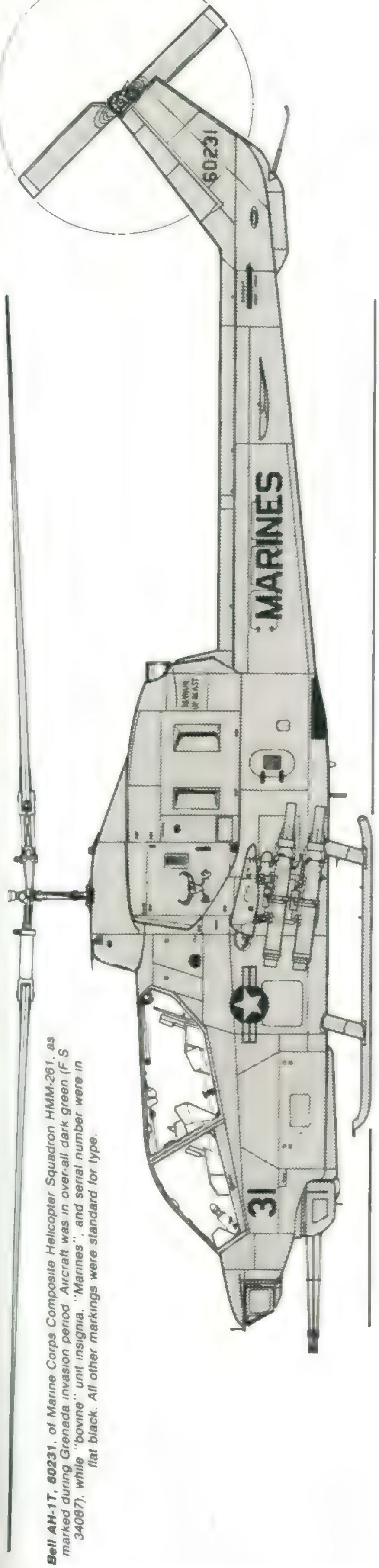
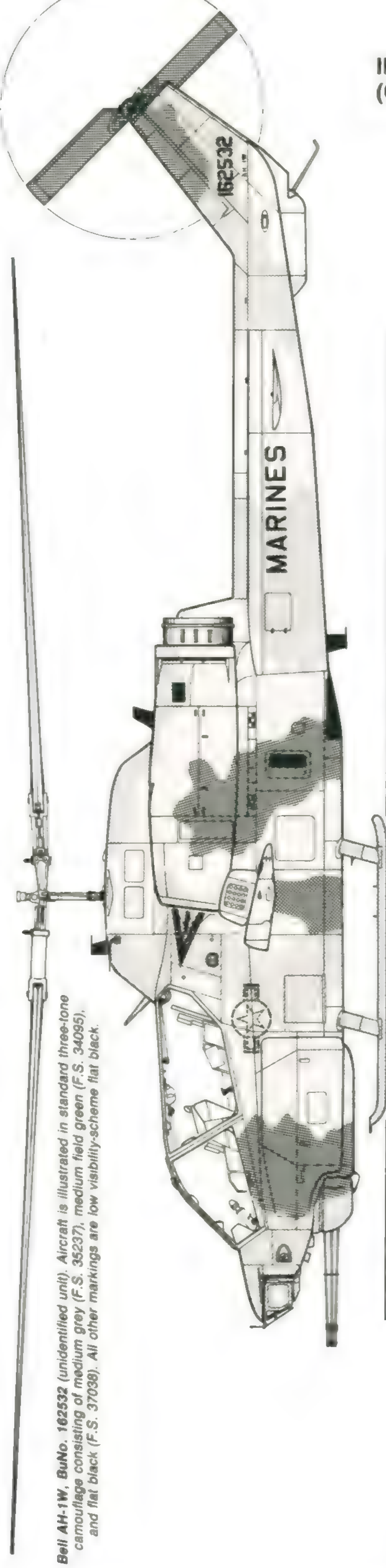
Drawn by Mike Wagnon

BELL AH-1G, 69-16440



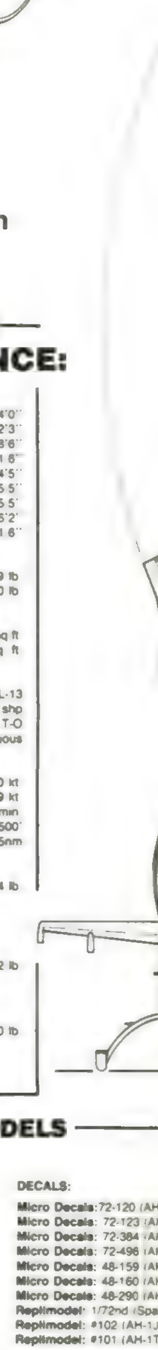
Bell AH-1T, 60231, of Marine Corps Composite Helicopter Squadron HMM-261, as marked during Grenada invasion period. Aircraft was in over-all dark green (F.S. 34087), while "bovine" unit insignia, "Marines", and serial number were in flat black. All other markings were standard for type.



Bell AH-1W, BuNo. 162532 (unidentified unit). Aircraft is illustrated in standard three-tone camouflage consisting of medium grey (F.S. 35237), medium field green (F.S. 34095), and flat black (F.S. 37038). All other markings are low visibility-scheme flat black.

IR SUPPRESSOR
(CUTAWAY)

Bell AH-1G, '16440, as se
August 1975. The aircraft
ably F.S. 11136). Sharkmo
warning band was yellow
panel, intake panel, and



Scale: 1/72nd

Drawn by Mike Wagnon

BELL AH-1G SPECIFICATIONS—AND PERFORMANCE:

Dimensions, External:	
Main rotor diameter	44'0"
Main rotor blade cord	2'3"
Tail rotor diameter	8'6"
Length overall, rotors turning	52'11.6"
Length of fuselage	44'5"
Width of fuselage	3'5.5"
Height overall, to tail rotor tip	13'5.5"
Elevator span	6'2"
Wing span	10'11.6"
Weights:	
Weight empty	5,809 lb
Max T-O weight	9,500 lb
Areas:	
Main rotor disc	1,520.5 sq ft
Tail rotor disc	56.7 sq ft
Powerplant and Transmission:	
Engine type	Lycoming T53-L-13
Engine rating	1,400 shp
Transmission rating	1,100 shp T-O
	1,100 shp continuous
General Performance:	
Never-exceed speed	190 kt
Max. level flight speed	149 kt
Max. VROC at S/L	1,680'/min
Service ceiling	11,500'
Hovering ceiling (IGE)	315nm
Armament Configurations:	
Mission A	9,034 lb
40mm Grenades, 250 rds	
7.62mm, 4,000 rds	
2.75" Rockets, M-159, 14 rds	
Fuel, 1,684 lb	
Mission B	9,482 lb
7.62mm, 8,000 rds	
2.75" Rockets, M-159, 28 rds	
Fuel, 1,684 lb	
Mission C	9,500 lb
7.62mm, 4,000 rds	
2.75" Rockets, M-159, 76 rds	
Fuel, 889 lb	

AVAILABLE SCALE MODELS AND DECALS:

MODELS:

Ace (AH-1S): 1/72nd
Ace (AH-1J): 1/72nd
Ben Hobby (AH-1G): 1/100th
Fujimi (AH-1S): 1/72nd (First Production Model)
Fujimi (AH-1J): 1/72nd (*SeaCobra*)
Fujimi (AH-1S): 1/72nd (Step III)
Fujimi (AH-1G): 1/48th (Black Bunny)
Fujimi (AH-1S): 1/48th TOW
Fujimi (AH-1J): 1/48th
Italeri (AH-1W): 1/72nd
Italeri (AH-1T): 1/72nd
Lindberg (AH-1G): 1/48th (Snap)
Matchbox (AH-1G): 1/72nd
Minicraft (AH-1G): 1/48th
Monogram (AH-1G): 1/72nd
Monogram (AH-1S): 1/48th (Step III)
Revell (AH-1G): 1/32nd
Roco (AH-1G): 1/87th
Tamiya (AH-1G): 1/100th
Testors (AH-1W): 1/72nd
Testors (AH-1T): 1/72nd

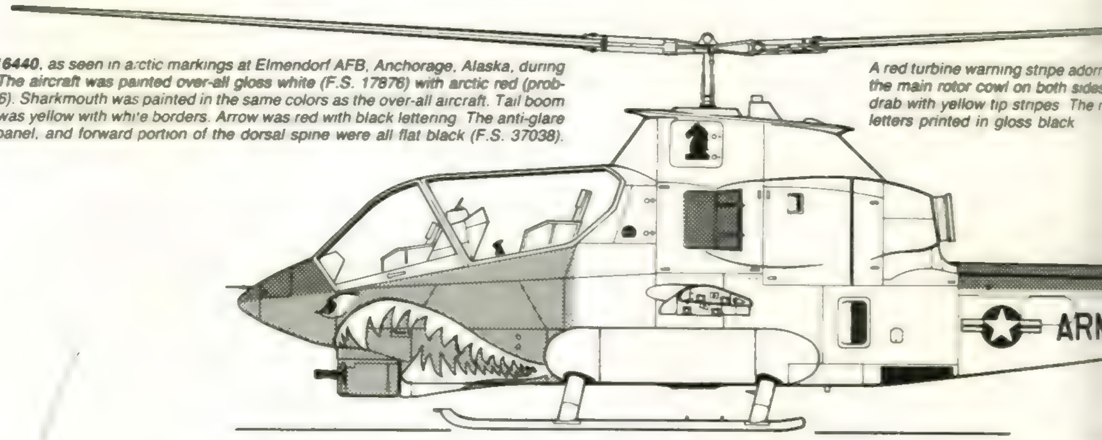
DECALS:

Micro Decals: 72-120 (AH-1
Micro Decals: 72-123 (AH-
Micro Decals: 72-384 (AH-
Micro Decals: 72-496 (AH-
Micro Decals: 48-159 (AH-
Micro Decals: 48-160 (AH-
Micro Decals: 48-290 (AH-
Replimodel: 1/72nd (Spane
Replimodel: #102 (AH-1J L
Replimodel: #101 (AH-1T)

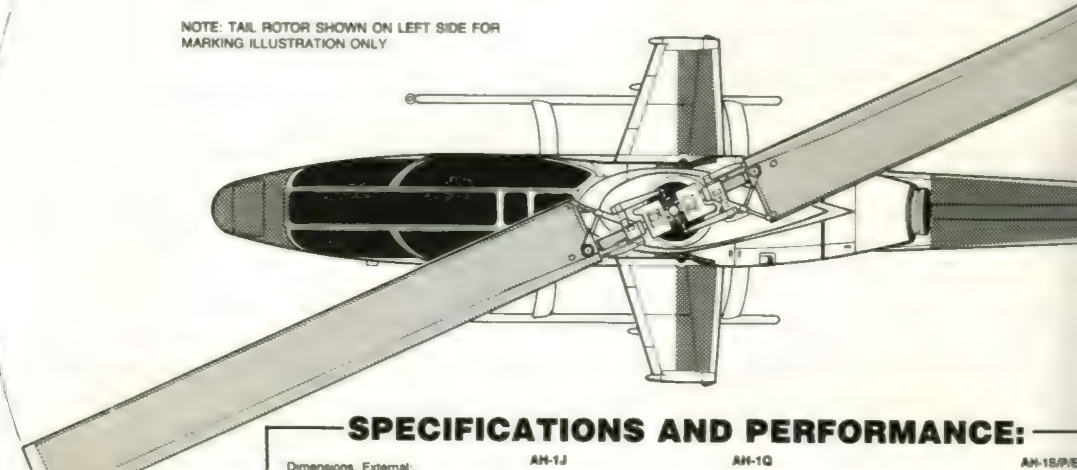
R SUPPRESSOR
(CUTAWAY)

Bell AH-1G, '16440, as seen in arctic markings at Elmendorf AFB, Anchorage, Alaska, during August 1975. The aircraft was painted over-all gloss white (F.S. 17876) with arctic red (probably F.S. 11136). Sharkmouth was painted in the same colors as the over-all aircraft. Tail boom warning band was yellow with white borders. Arrow was red with black lettering. The anti-glare panel, intake panel, and forward portion of the dorsal spine were all flat black (F.S. 37038).

A red turbine warning stripe adorn the main rotor cowl on both sides drab with yellow tip stripes. The r letters printed in gloss black

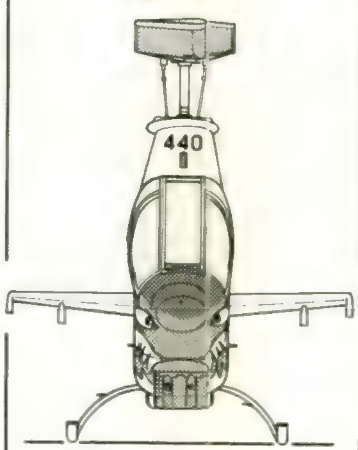


NOTE: TAIL ROTOR SHOWN ON LEFT SIDE FOR MARKING ILLUSTRATION ONLY



Scale: 1/72nd

Drawn by Mike Wagnon



BELL AH-1G SPECIFICATIONS— AND PERFORMANCE:

Dimensions, External:	
Main rotor diameter	44'0''
Main rotor blade cord	2'3''
Tail rotor diameter	8'6''
Length overall rotors turning	52'11 6''
Length of fuselage	44'5''
Width of fuselage	3'5 5''
Height overall to tail rotor tip	13'5 5''
Elevator span	6'2''
Wing span	10'11 6''
Weights:	
Weight empty	5,809 lb
Max T-O weight	9,500 lb
Areas:	
Main rotor disc	1,520 5 sq ft
Tail rotor disc	56 7 sq ft
Powerplant and Transmission:	
Engine type	Lycoming T53-L-13
Engine rating	1,400 shp
Transmission rating	1,100 shp T-O 1,100 shp continuous
General Performance:	
Never-exceed spped	190 kt
Max level flight speed	149 kt
Max VROC at S/L	1,680'/min
Service ceiling	11,500'
Hovering ceiling (IGE)	315nm
Armament Configurations:	
Mission A 40mm Grenades, 250 rds 7 62mm, 4,000 rds 2 75'' Rockets, M-159, 14 rds Fuel, 1,684 lb.	9,034 lb
Mission B 7 62mm, 8,000 rds. 2 75'' Rockets, M-159, 26 rds. Fuel, 1,684 lb.	9,482 lb.
Mission C 7.62mm, 4,000 rds. 2.75'' Rockets, M-159, 76 rds. Fuel, 669 lb.	9,500 lb.

AVAILABLE SCALE MODELS AND DECALS:

MODELS:

Ace (AH-1S): 1/72nd
Ace (AH-1J): 1/72nd
Ben Hobby (AH-1G): 1/100th
Fujimi (AH-1S): 1/72nd (First Production Model)
Fujimi (AH-1J): 1/72nd (*SeaCobra*)
Fujimi (AH-1S): 1/72nd (Step III)
Fujimi (AH-1G): 1/48th (Black Bunny)
Fujimi (AH-1S): 1/48th TOW
Fujimi (AH-1J): 1/48th
Italeri (AH-1W): 1/72nd
Italeri (AH-1T): 1/72nd
Lindberg (AH-1G): 1/48th (Snap)
Matchbox (AH-1G): 1/72nd
Minicraft (AH-1G): 1/48th
Monogram (AH-1G): 1/72nd
Monogram (AH-1S): 1/48th (Step III)
Revell (AH-1G): 1/32nd
Roco (AH-1G): 1/87th
Tamiya (AH-1G): 1/100th
Testors (AH-1W): 1/72nd
Testors (AH-1T): 1/72nd

DECALS:

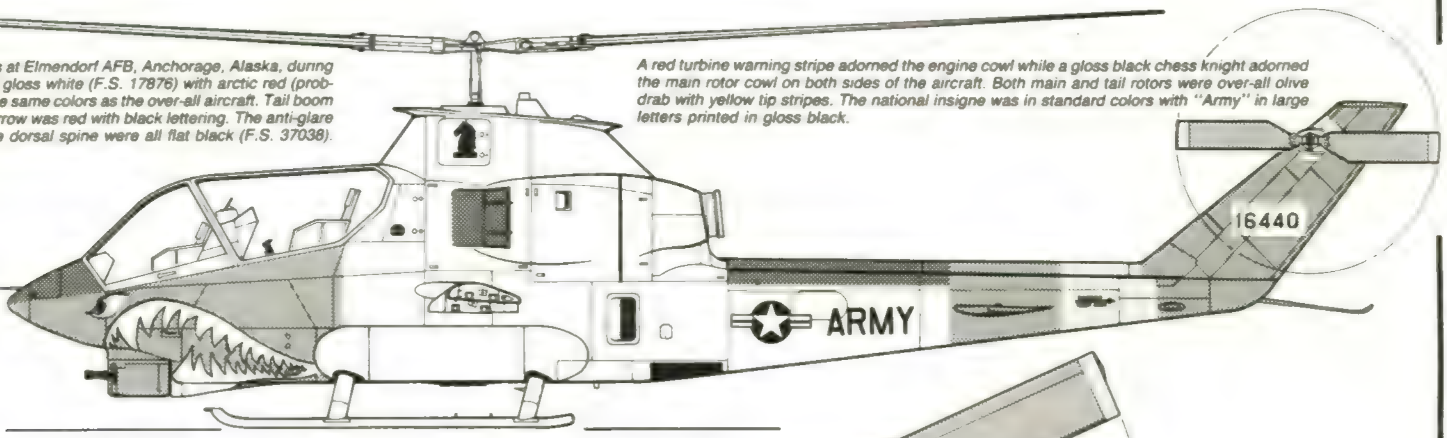
Micro Decals:72-120 (AH-1J and other Navy Helios)
Micro Decals: 72-123 (AH-1G and UH-1D)
Micro Decals: 72-384 (AH-1J and AH-1G)
Micro Decals: 72-496 (AH-1G)
Micro Decals: 48-159 (AH-1G NASA)
Micro Decals: 48-160 (AH-1G USMC AH-1J)
Micro Decals: 48-290 (AH-1G)
Replimodel: 1/72nd (Spanish)
Replimodel: #102 (AH-1J Lov Vis)
Replimodel: #101 (AH-1T)

SPECIFICATIONS AND PERFORMANCE:

	AH-1J	AH-1Q	AH-1S/P/E
Dimensions, External:			
Main rotor diameter	44'0''	44'0''	44'0''
Main rotor blade cord	2'3''	2'3''	2'6'' (Kam
Tail rotor diameter	8'6''	8'6''	8'6''
Length overall rotors turning	53'5''	53'0''	53'1''
Length of fuselage	44'7''	44'5''	44'7''
Width of fuselage	3'0''	3'5.5''	3'2.5''
Height overall to tail rotor tip	13'6''	13'6''	13'2''
Elevator span	6'11''	6'11''	6'11''
Wing span	10'4''	10'9''	10'9''
Weights			
Weight empty	6,610 lb.	6,301 lb.	6,310 lb (6,479 lb (6,419 lb (6,598 lb (
Max T-O weight	10,000 lb.	9,500 lb.	10,000 lb
Areas			
Main rotor disc	1,520.5 sq.'	1,520.5 sq.'	1,520 5 sq
Tail rotor disc	56 7 sq.'	56.7 sq.'	56 7 sq.
Powerplant and Transmission			
Engine type	T400-CP-400	T53-L-13	T53-L-703
Engine rating	1,800 shp	1,400 shp	1,800 shp
Transmission rating	1,250 shp T-O 1,100 shp continuous	1,100 shp T-O 1,100 shp continuous	1,290 shp T-O 1,134 shp continuous
General Performance: Never-exceed speed	180 kt. (207 mph)	190 kt. (219 mph)	170 kt (196 mph)
Max. level flight speed	180 kt. (207 mph)	149 kt. (171 mph)	128 kt (147 mph)
Max VROC at S/L	1,090'/min.	1,680'/min.	1,620'/min
Service ceiling	10,500 ft.	11,500 ft.	12,400 ft
Max range, internal fuel at S/L	310 NM	315 NM	280 NM

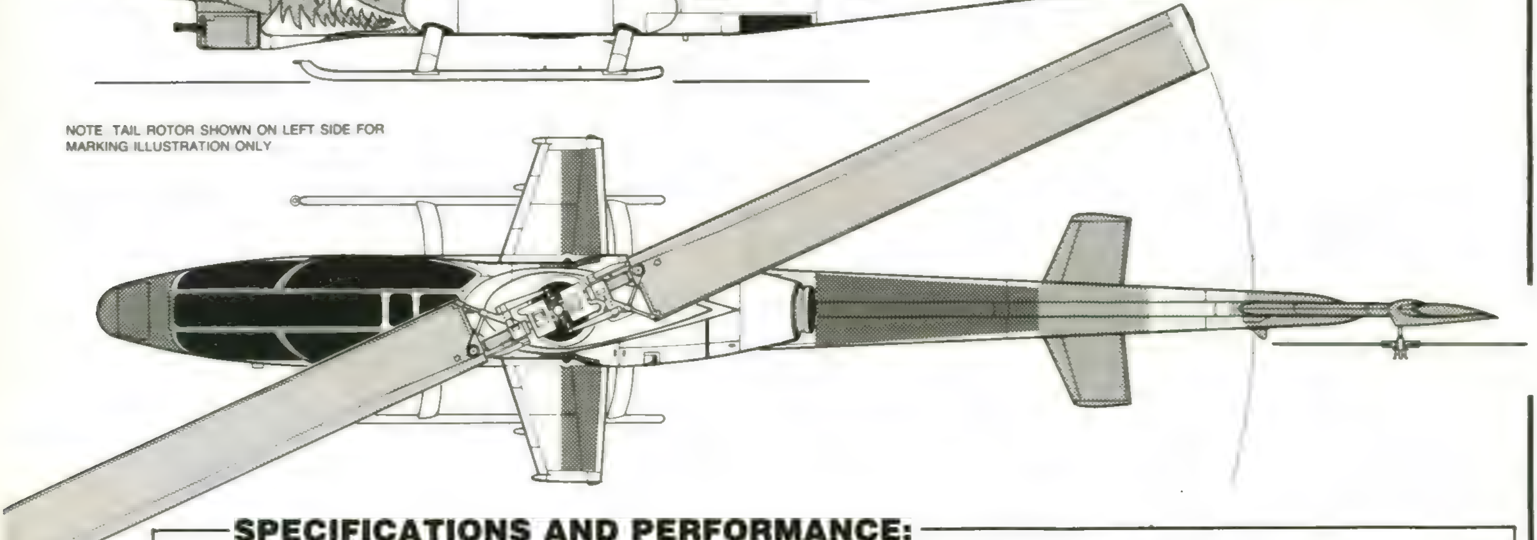
Armament Configurations:

AH-1J	AH-1Q	AH-1S
Basic Combat—9,858 lbs. 20mm cannon, 750 rds. 2 75'' RKTS, LAU-68, 14 rds Fuel, 1,800 lbs.	**Mission A**—9,379 lbs. 40mm grenades, 250 rds. 7 62mm, 4,000 rds TOW missiles, 8 rds Fuel, 1,187 lbs	**Mission A**—9,935 lbs. 7.62mm, 8,000 rds. TOW missiles, 8 rds Fuel, 1,684 lbs
Medium Combat—10,000 lbs 20mm cannon, 750 rds 2 75'' RKTS, LAU-68, 14 rds 7.62mm, M18, 250 rds. Fuel, 1,113 lbs.	**Mission B**—9,480 lbs 7 62mm, 8,000 rds TOW missiles, 8 rds. Fuel, 1,329 lbs.	**Mission B**—10,000 lbs 7 62mm, 4,000 rds 2.75'' RKTS,M158,14 rds. TOW missiles, 8 rds. Fuel, 1,682 lbs
Heavy Combat—10,000 lbs. 20mm cannon, 155 rds. 2.75'' RKTS, LAU-61/68, 52 rds. Fuel, 396 lbs.	**Mission C**—9,500 lbs. 7.62mm, 4,000 rds. 2.75'' RKTS,M158,14 rds. TOW missiles, 8 rds. Fuel, 1,182 lbs	



ctic markings at Elmendorf AFB, Anchorage, Alaska, during nted over-all gloss white (F.S. 17876) with arctic red (prob- painted in the same colors as the over-all aircraft. Tail boom e borders. Arrow was red with black lettering. The anti-glare portion of the dorsal spine were all flat black (F.S. 37038).

A red turbine warning stripe adorned the engine cowl while a gloss black chess knight adorned the main rotor cowl on both sides of the aircraft. Both main and tail rotors were over-all olive drab with yellow tip stripes. The national insigne was in standard colors with "Army" in large letters printed in gloss black.



NOTE TAIL ROTOR SHOWN ON LEFT SIDE FOR MARKING ILLUSTRATION ONLY

Navy Helios)
D)
G)

H-1J)

SPECIFICATIONS AND PERFORMANCE:

	AH-1J	AH-1Q	AH-1S/P/E/F	AH-1T	AH-1W
Dimensions, External					
Main rotor diameter	44'0"	44'0"	44'0"	48'0"	48'0"
Main rotor blade cord	2'3"	2'3"	2'6" (Kaman)	2'9"	2'9"
Tail rotor diameter	8'6"	8'6"	8'6"	9'8"	9'9"
Length overall rotors turning	53'5"	53'0"	53'1"	58'0"	58'0"
Length of fuselage	44'7"	44'5"	44'7"	45'8"	44'9"
Width of fuselage	3'0"	3'5 5"	3'2 5"	3'2 5"	3'7"
Height overall to tail rotor tip	13'6"	13'6"	13'2"	14'3"	13'9"
Elevator span	6'11"	6'11"	6'11"	6'11"	6'11"
Wing span	10'4"	10'9"	10'9"	10'7"	10'9"
Weights					
Weight empty	6,610 lb	6,301 lb	6,310 lb (S) 6,479 lb (P) 6,419 lb (E) 6,598 lb (F)	8,553 lb	10,255 lb
Max T-O weight	10,000 lb	9,500 lb	10,000 lb	14,000 lb	14,750 lb
Areas					
Main rotor disc	1,520 5 sq '	1,520 5 sq '	1,520 5 sq '	1,809 5 sq '	1,809 5 sq '
Tail rotor disc	56 7 sq '	56 7 sq '	56 7 sq '	74 0 sq '	74 0 sq '
Powerplant and Transmission					
Engine type	T400-CP-400	T53-L-13	T53-L-703	T400-WV-402	(2)T700-GE-401
Engine rating	1,800 shp	1,400 shp	1,800 shp	1,970 shp	1,725 shp
Transmission rating	1,250 shp T-O 1,100 shp continuous	1,100 shp T-O 1,100 shp continuous	1,290 shp T-O 1 134 shp continuous	1,970 shp T-O 1,637 shp continuous	2,030 shp T-O —
General Performance					
Never-exceed speed	180 kt (207 mph)	190 kt (219 mph)	170 kt (196 mph)	190 kt (219 mph)	190 kt (219 mph)
Max level flight speed	180 kt (207 mph)	149 kt (171 mph)	128 kt (147 mph)	149 kt (171 mph)	162 kt (186 mph)
Max VROC at S/L	1,090 /min	1,680'/min	1,620'/min	1,785 /min	2,000'/min
Service ceiling	10,500 ft	11,500 ft	12 400 ft	7,400 ft	20,000 ft
Max range, internal fuel at S/L	310 NM	315 NM	280 NM	228 NM	350 NM

Armament Configurations:	AH-1J	AH-1Q	AH-1S	AH-1P/E/F	AH-1T	AH-1W
	Basic Combat—[illegible] lbs 20mm cannon, 750 rds 2 75" RKTS, LAU-68, 14 rds Fuel, 1,600 lbs	**Mission A**—9,379 lbs 40mm grenades, 250 rds 7 62mm, 4,000 rds TOW missiles, 8 rds Fuel, 1,187 lbs	**Mission A**—9,935 lbs 7 62mm 8,000 rds TOW missiles 8 rds Fuel, 1,684 lbs	**Mission A**—9,978 lbs 20mm cannon 750 rds TOW missiles, 4 rds Fuel, 1,684 lbs	**Basic Combat**—12,321 lbs 20mm cannon, 750 rds 2 75" RKTS, LAU-68, 14 rds Fuel, 2,120 lbs	**Basic Combat**—13,414 lbs 20mm cannon 750 rds 2 75 RKTS, LAU-68, 14 rds Fuel, 2,086 lbs
	Medium Combat—10,000 lbs 20mm cannon, 750 rds 2 75" RKTS, LAU-68, 14 rds 7 62mm, M18, 250 rds Fuel, 1,113 lbs	**Mission B**—9,480 lbs 7 62mm, 8,000 rds TOW missiles, 8 rds Fuel, 1,329 lbs	**Mission B**—10,000 lbs 7 62mm 4 000 rds 2 75" RKTS,M158,14 rds TOW missiles, 8 rds Fuel, 1,682 lbs	**Mission B**—10,000 lbs 20mm cannon 750 rds 2 75"RKTS M260,14 rds Fuel, 1,489 lbs	**Medium Combat**—12,976 lbs 20mm cannon, 75 rds 2 75" RKTS, LAU-68, 14 rds 7 62mm, M18, 2,500 rds Fuel, 2,120 lbs	**Medium Combat**—14,750 lbs 20mm cannon, 284 rds 2 75" RKTS, LAU-68, 14 rds 7 62mm, M18, 2,500 rds Fuel, 1,792 lbs
	Heavy Combat—10,000 lbs 20mm cannon, 155 rds 2.75" RKTS, LAU-61/68, 52 rds. Fuel, 395 lbs	**Mission C**—9,500 lbs 7 62mm, 4,000 rds 2 75" RKTS,M158,14 rds TOW missiles, 8 rds Fuel, 1,182 lbs		**Mission C**—10,000 lbs 20mm cannon, 750 rds TOW missiles, 8 rds Fuel, 1,370 lbs	**Basic Anti-armor**—12,120 lbs 20mm cannon, 750 rds TOW missiles, 4 rds Fuel, 2,120 lbs	**Basic Anti-armor**—13,716 lbs 20mm cannon, 750 rds TOW missiles, 4 rds *Hellfire* missiles, 4 rds Fuel, 2,086 lbs
					Heavy Anti-armor—12,994 lbs. 20mm cannon, 750 rds TOW missiles, 8 rds 2 75" RKTS, LAU-68, 14 rds Fuel, 2,120 lbs	**Heavy Anti-armor**—14,360 lbs 20mm cannon, 284 rds 2 chaff dispensers *Hellfire* missiles, 8 rds 2 75' RKTS, LAU-68, 14 rds Fuel, 2,086 lbs

Jay Miller/Aerofax, Inc

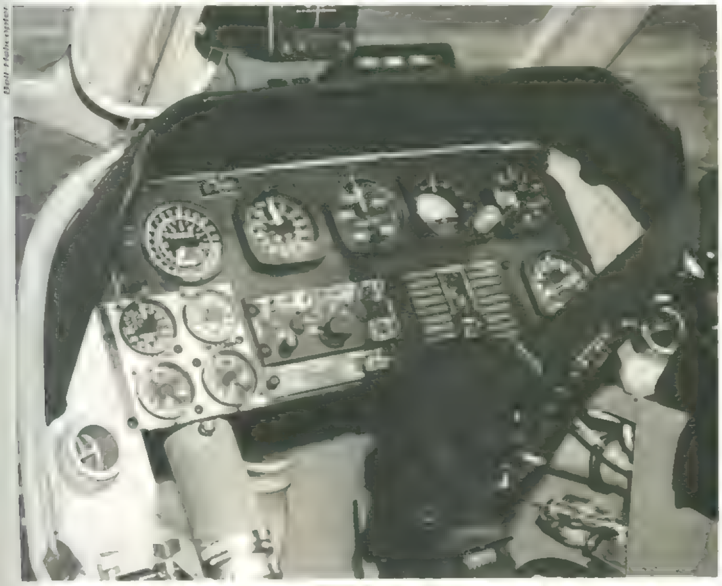
Jay Miller/Aerofax, Inc

Rear, pilot's cockpits of the **AH-1S** (left) and the **AH-1W** (right) Instrumentation for both, including the more advanced AH-1W, remains almost totally analogue. The AH-1W's AN/APR-39 radar warning scope is mounted on top of the panel, whereas that for the AH-1S is mounted in the panel proper Additionally, The AH-1S has a rocket/gun HUD-type sighting unit mounted centrally on top of the panel Cyclics and collectives are conventional in position and usage in both types

Jay Miller/Aerofax, Inc

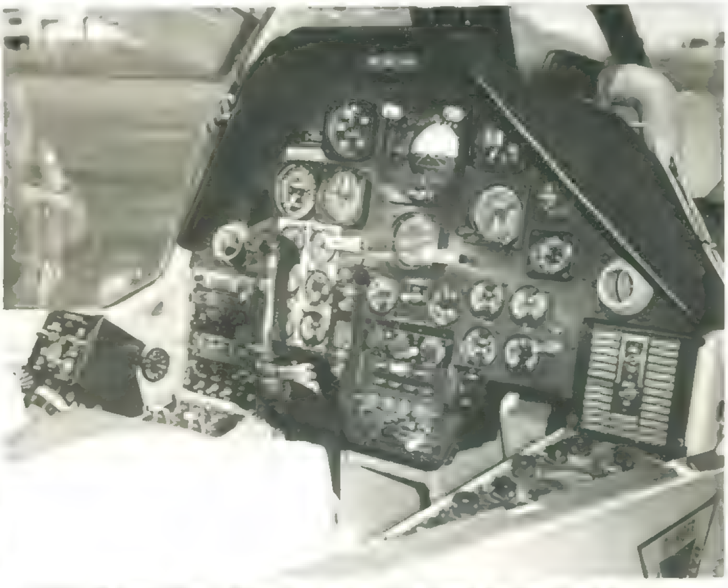
AH-1G (left) and **AH-1W** (right) forward cockpits AH-1G pantographic gun/rocket sighting unit was slaved to the chin turret, in turn, was operated by grip triggers. Cyclic control grip is visible to right. AH-1W forward cockpit is dominated by TOW sighting unit mounted centrally This unit is slaved to the nose-mounted M65 TSU. The latter provides the aircraft gunner/copilot with a stabilized telescopic view of a potential target. Cyclic control grip is visible to right

An early production AH-1G forward cockpit showing the floor-mounted pantograph gun-sight with its jump compensation system. The hand-held viewing sight is operated by the copilot/gunner and is slaved to the chin turret. Grips are provided on either side of the sight and trigger buttons are mounted on the tops of each grip. The forward cockpit instrument panel provides the copilot/gunner with basic performance and flight control information. The forward cockpit cyclic control stick is visible on the right.

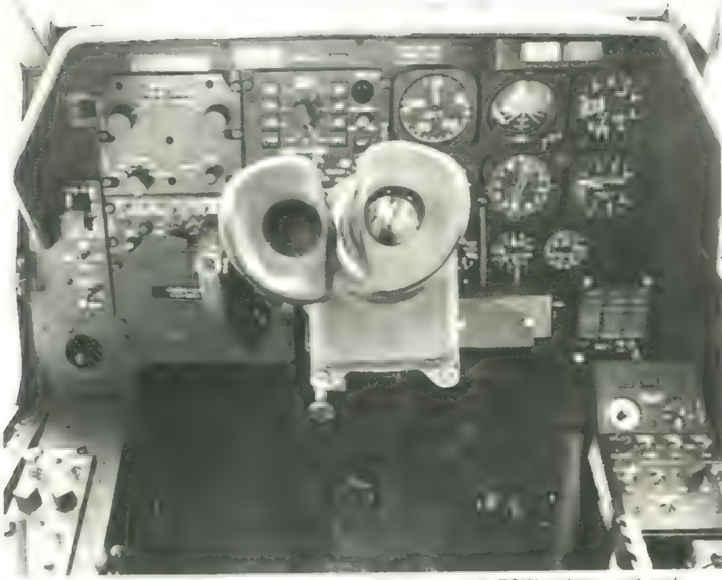


Iranian Air Force AH-J, 3-4401, forward cockpit differs only in detail from that of Marine Corps counterpart. Instrument panel is minimally equipped with flight and powerplant related instrumentation. Armament system is controlled from consoles.

Bell Helicopter



Iranian Air Force AH-1J, 3-4401, aft cockpit. The aircraft is piloted from this position and accordingly, the instrument panel is optimized to provide flight and powerplant information. 20mm gun control panel is centrally mounted.



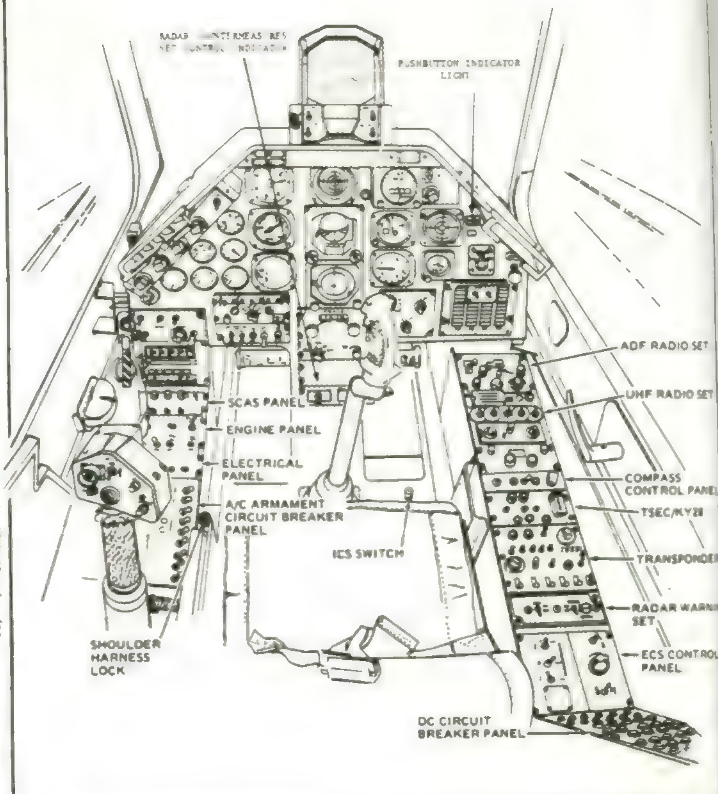
Bell Helicopter

AH-1S, 76-22575, forward cockpit. Centrally mounted is TOW sighting unit and associated grip. Centrally located on instrument panel, ahead of sight, is TOW control panel. Other instrumentation primarily is flight and communications oriented.

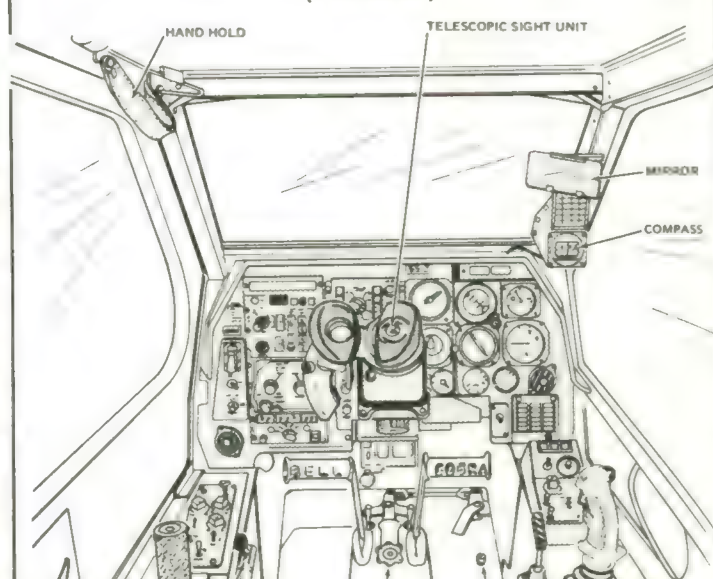
Jay Miller/Aerofax Inc.

AH-1S, 76-22706, aft cockpit. Visible above instrument panel is HUD, which initially was installed as part of the ECAP update. Included with the latter was a fire control computer, an air data subsystem, and the LAAT laser ranging system.

AH-1S PILOT STATION DIAGRAM (TYPICAL)



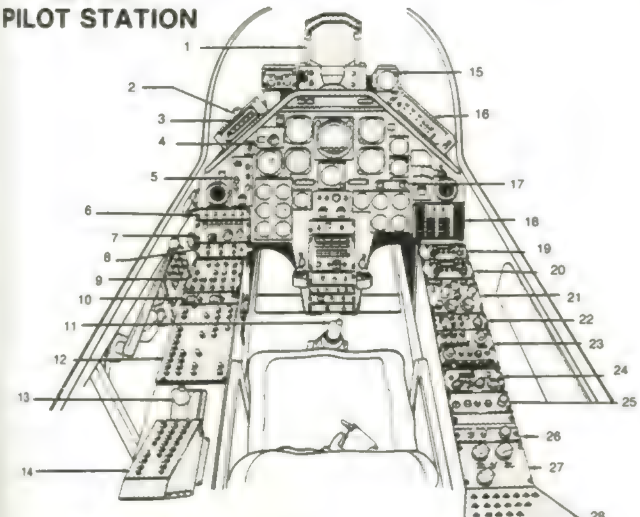
AH-1S GUNNER STATION DIAGRAM (TYPICAL)



AH-1W, BuNo. 162574, forward cockpit. The Canadian Marconi joint TOW/"Hellfire" control and display panel is visible on the left side of the main panel. Hughes telescopic sight unit for TOW protrudes from center of panel.

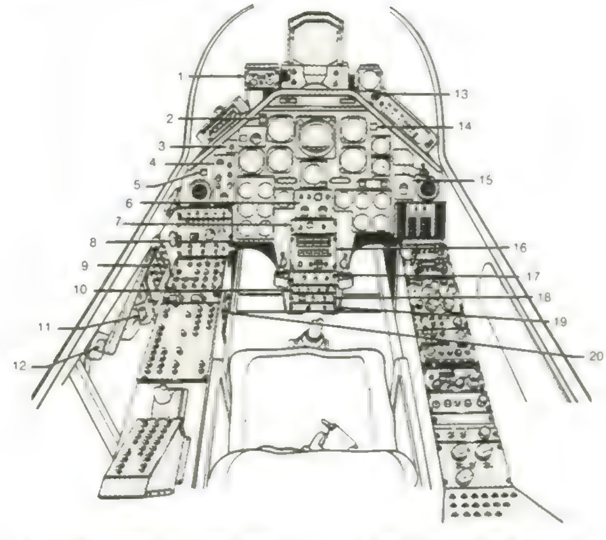
AH-1W, BuNo. 162536, aft cockpit. HUD and AN/APR-39 radar warning scope are visible mounted on top of panel. Other instrumentation primarily is flight control and powerplant related. Stores control panel is lower center.

AH-1W PILOT STATION



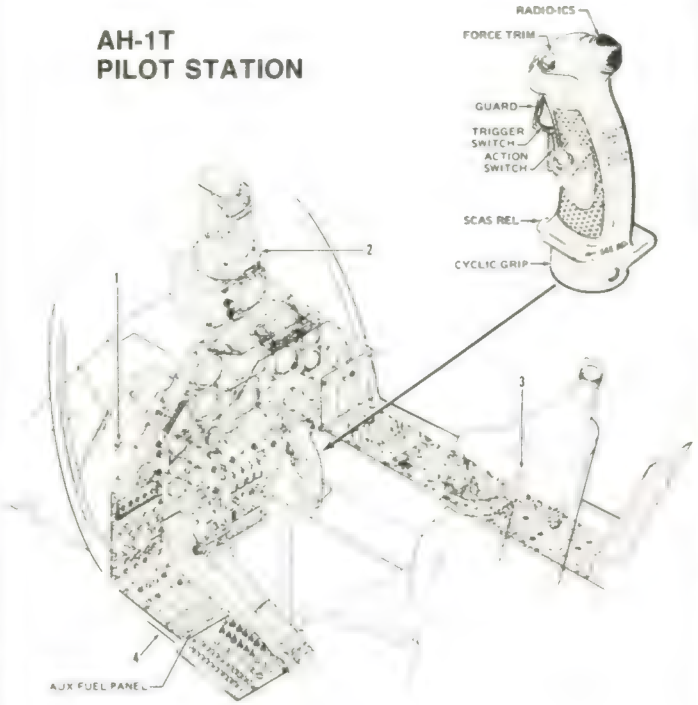
1. HEAD UP DISPLAY
2. CANOPY REMOVAL SYSTEM HANDLE
3. AIM-9 COCKPIT CONTROL UNIT
4. *HELLFIRE* PILOT CONTROL PANEL
5. MISCELLANEOUS CONTROL PANEL
6. EMERGENCY JETTISON SELECT PANEL
7. CSC PANEL
8. SCAS PANEL
9. ENGINE CONTROL PANEL
10. AUX FUEL PANEL
11. CYCLIC STICK
12. AC CIRCUIT BREAKER PANEL
13. COLLECTIVE STICK
14. ARMAMENT CIRCUIT BREAKER PANEL
15. APR-39 RADAR INDICATOR
16. ALE-39 COCKPIT CONTROL UNIT
17. GEARBOX CHIP INDICATOR
18. CAUTION ADVISORY PANEL
19. COMMAND UHF/VHF RADIO
20. TACTICAL UHF/VHF RADIO
21. ADF RADIO
22. TSEC/KY 58
23. IFF TRANSPONDER
24. TACAN
25. COMPASS
26. RAIN RMV/PITOT HTR/ECM
27. LIGHTS CONTROL PANEL
28. DC CIRCUIT BREAKER PANEL

AH-1W PILOT STATION



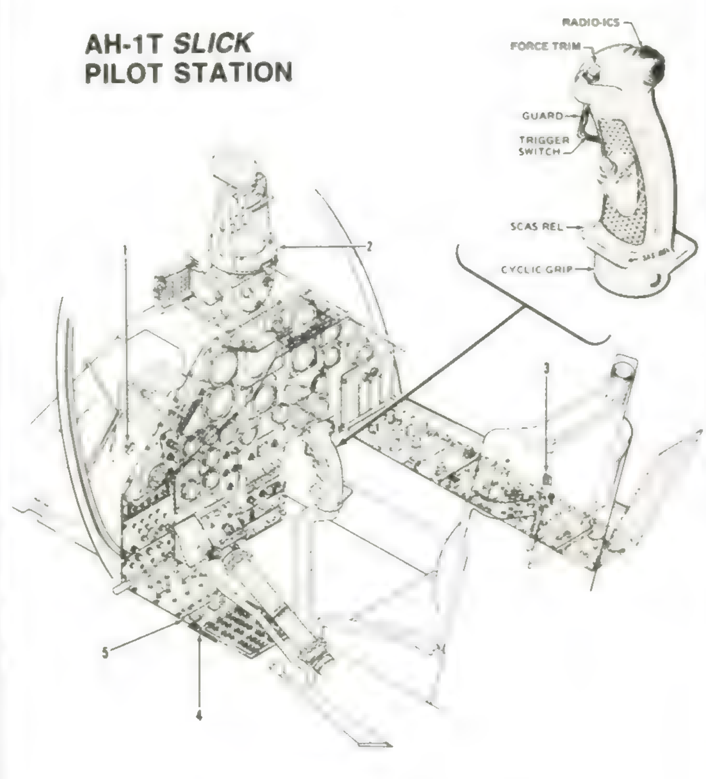
1. GUNNER ACCURACY CONTROL PANEL
2. VIBRATION SUPPRESSION SYSTEM SWITCH
3. FIRE EXTINGUISHER SWITCH
4. TOW WIRE CUT SWITCH
5. MSL DEICE SWITCH
6. ARMAMENT CONTROL PANEL
7. ARMAMENT CONTROL PANEL
8. FREE AIR TEMP
9. SMOKE CONTROL PANEL
10. APR-39 RADAR DETECTOR
11. HMS LAUNCHER ARM SWITCH
12. ROTOR BRAKE HANDLE
13. SAM/A1 WARNING LIGHT
14. TURRET STOW LIGHT
15. DCVM SWITCH
16. STORE CONTROL PANEL
17. APN154 RADAR BEACON
18. APR-44 RADAR WARNING
19. ALQ-144 COUNTERMEASURES
20. ENGINE GOVERNOR CONTROL PANEL

AH-1T PILOT STATION



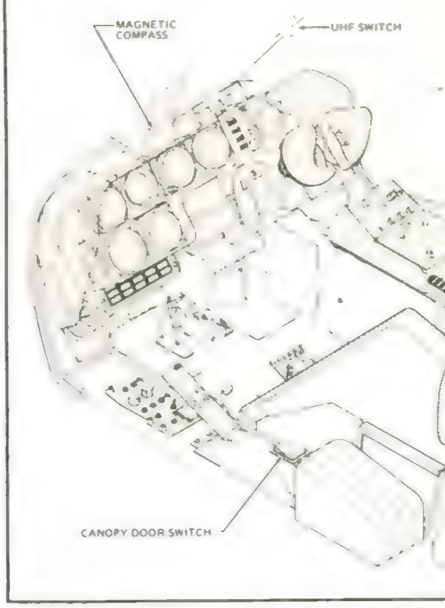
1 LEFT DEFROST (RH NOT SHOWN)
2 PILOT FIXED SIGHT
3 CANOPY DOOR SWITCH
4 SMOKE GRENADE CONTROL PANEL (NOT SHOWN)

AH-1T SLICK PILOT STATION

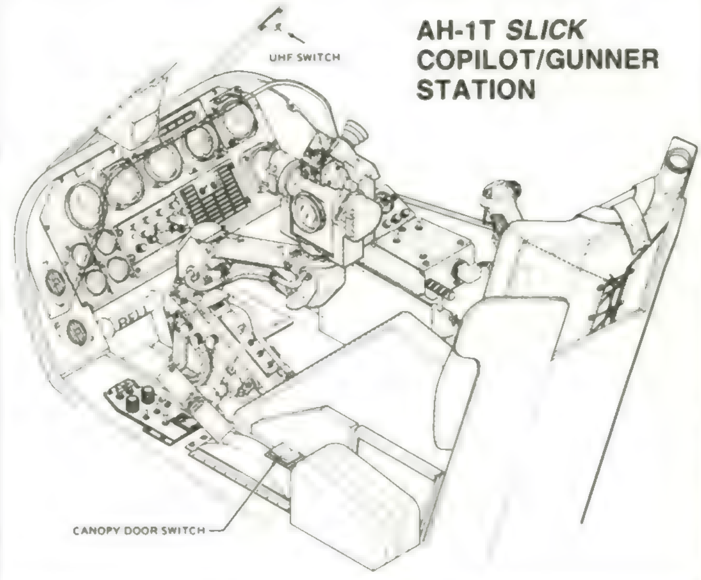


1. LEFT DEFROST (RH NOT SHOWN)
2 PILOT FIXED SIGHT
3. CANOPY DOOR SWITCH
4. SMOKE GRENADE CONTROL PANEL (NOT SHOWN)
5 AUXILIARY FUEL PANEL

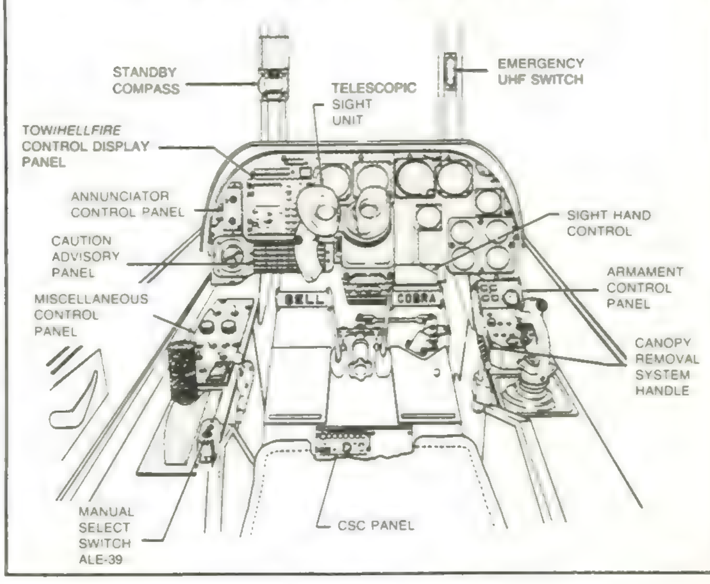
AH-1T COPILOT/ GUNNER STATION



AH-1T *SLICK* COPILOT/GUNNER STATION



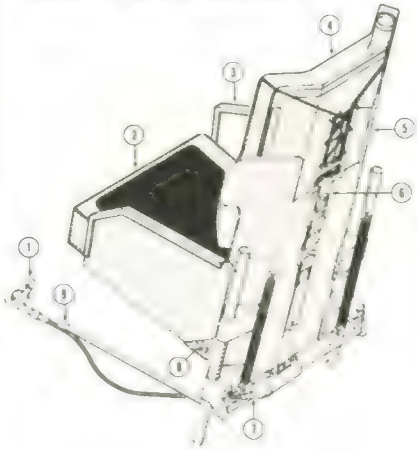
AH-1W COPILOT/GUNNER STATION



Jay Miller/Aerofax, Inc

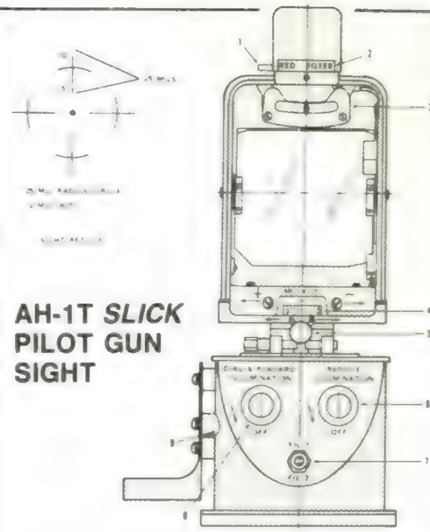
Forward cockpit of AH-1S, looking aft. Armored seat has buttock and back pads that are heated and air-conditioned to provide maximum crew comfort.

AH-1S PILOT SEAT INSTALLATION



1. SHOULDER HARNESS LOCK
2. SEAT CUSHION
3. SIDE ARMOR PANELS
4. SEAT BACK CUSHION
5. SEAT ASSEMBLY
6. SHOULDER HARNESS
7. INERTIA REEL
8. SEAT LAP BELT
9. HEIGHT ADJUSTMENT HANDLE

AH-1T *SLICK* PILOT GUN SIGHT



1. FILTER LOCKING HATCH
2. FILTER PLATE
3. INCLINOMETER
4. ILS SETTING WINDOW
5. MILS SETTING ADJUSTING LEVER
6. RETICLE INTENSITY RHEOSTAT
7. FILAMENT SELECTOR SWITCH
8. PLACARD RANGE TABLE AND MILS SETTING WINDOW INTENSITY RHEOSTAT
9. PLACARD RANGE TABLES

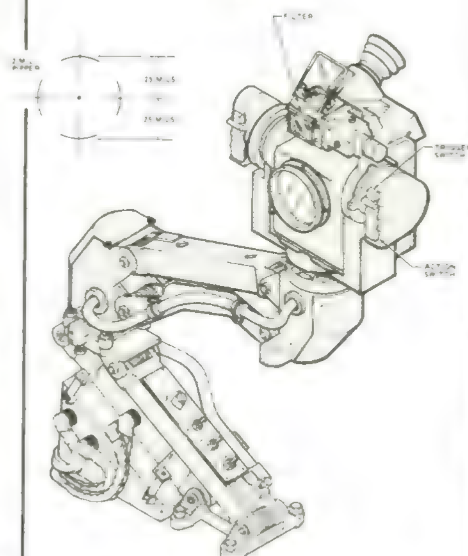
Jay Miller/Aerofax, Inc

Forward cockpit of AH-1W, looking aft. Hose for heating/air-conditioning is visible at seat top, along with part of armor plate backing.

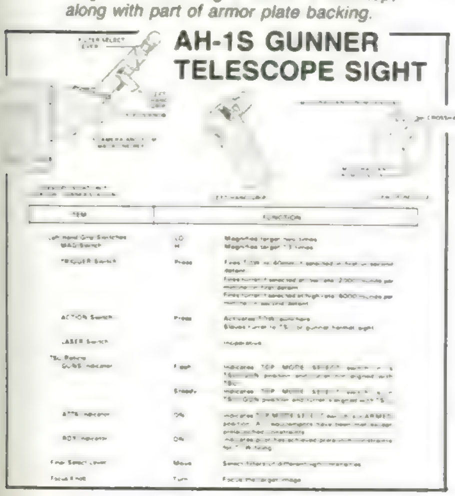
Jay Miller/Aerofax, Inc

Rear cockpit of AH-1W, looking aft. Helmet mounted sight attachment system is visible upper right. Air conditioning hose is to the left.

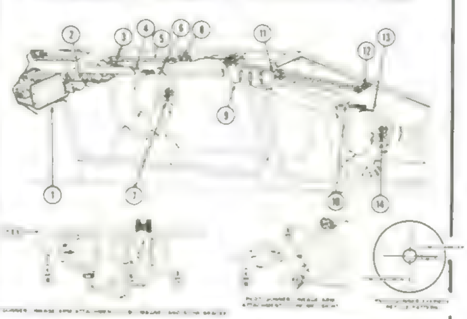
AH-1T *SLICK* COPILOT/GUNNER SIGHT



AH-1S GUNNER TELESCOPE SIGHT

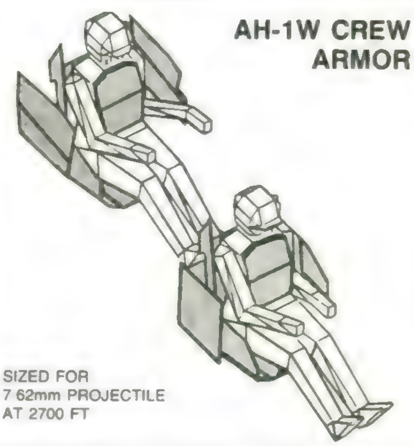


HELMET SIGHT SUBSYSTEM



1. Electronic interface assembly
2. Gunner extension cable
3. Pilot linkage cable
4. Pilot linkage arm
5. Pilot linkage rails
6. Pilot helmet sight
7. Pilot eyepiece
8. Pilot linkage front support
9. Gunner linkage cable
10. Gunner linkage arm
11. Gunner linkage rails
12. Gunner linkage front support
13. Gunner helmet sight
14. Gunner eyepiece
15. BIT magnet
16. Stow bracket

AH-1W CREW ARMOR



SIZED FOR
7.62mm PROJECTILE
AT 2700 FT

Jay Miller/Aerofax, Inc

Slight bulge is visible in AH-1S glass transparencies indicating this to be an updated variant. Original configuration, sometimes referred to as "flat plate", had thicker framing and no transparency bulge. Reflection problems necessitated change.

Jay Miller/Aerofax, Inc

Relative flatness of AH-1S transparencies is apparent from almost any angle. Even the upper panels are "flat plated" in an attempt to improve strength and various reflectivity factors. Crew ingress and egress is through hinged side panels.

Jay Miller/Aerofax, Inc

Original AH-1S flat plate transparency required thicker framing and other changes. Because the flat panels increased the glint factor, and thus increased the aircraft's vulnerability, they were replaced by panels with a slight bulge.

Jay Miller/Aerofax, Inc

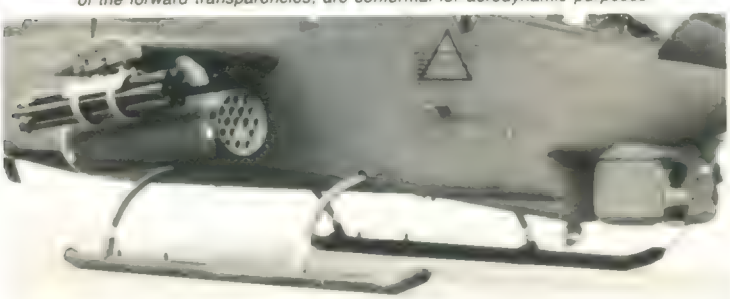
The AH-1W's forward windscreen assembly is very fighter-like in appearance and supercedes the earlier flat plate configuration by returning to the original conformal design. For forward cockpit access, the entire left side panel is hinged.

Jay Miller/Aerofax, Inc

The AH-1W's relatively frameless aft transparency provides an excellent view for the pilot. Only the right side panel is hinged for cockpit access. Aft panel, like those of the forward transparencies, are conformal for aerodynamic purposes

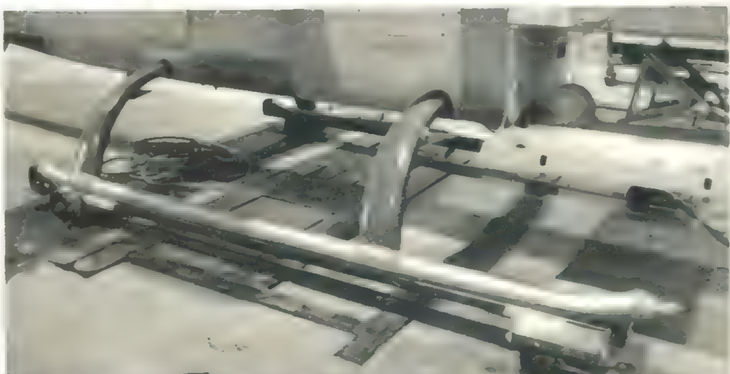
Jay Miller/Aerofax, Inc

AH-1W's forward hinged transparency is equipped with small gas actuator to hold it open. A similar unit is provided for the aft hinged transparency. Opposite access for each crew compartment facilitates ingress and egress.



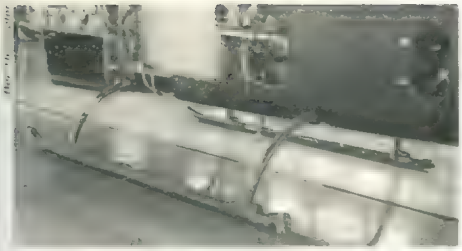
Jay Miller/Aerofax, Inc

Unfaired main skid of early AH-1G is conventionally tubular in concept. Simplicity marks its design as it creates limited drag, provides adequate support, requires virtually no maintenance, and is relatively inexpensive to manufacture.

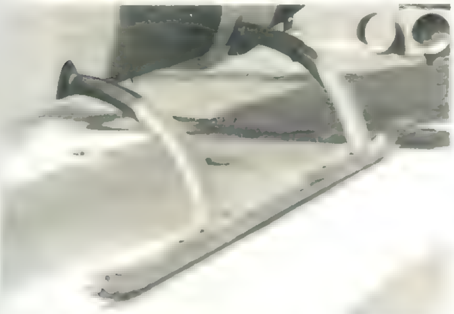


Jay Miller/Aerofax, Inc

Though structurally quite similar to the skid landing gear of its predecessors, the AH-1S gear differs somewhat in having tube fairings of slightly increased chord. These lowered the already minimal drag factor of the skid support arms.



AH-1T skids are dimensionally somewhat longer than those of earlier, single-engine configurations. In this view, the skid fairings have been removed



Jay Miller/Aerofax, Inc

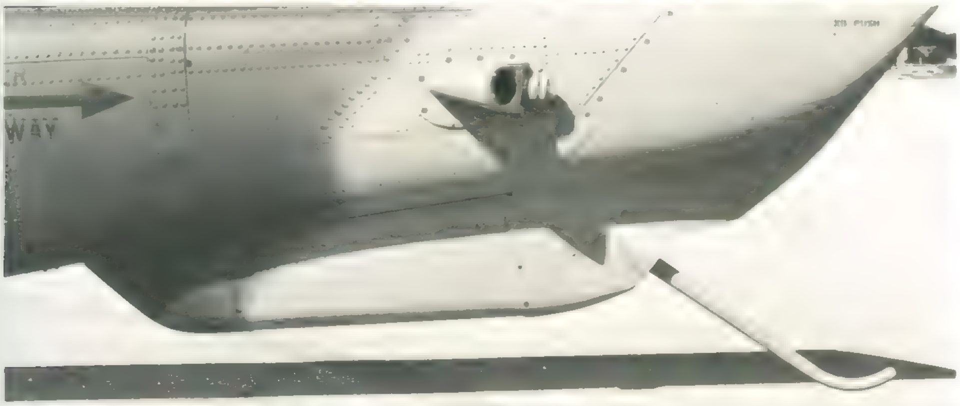
Virtually all AH-1s (AH-1W, shown) are equipped with mounting lugs for wheel attachment. The latter permit the aircraft to be moved on the ground

Bell Helicopter

For snow operations, particularly in countries like Japan, all versions of the AH-1 can be equipped with skis. Cutouts are for removable wheel attachments

Jay Miller/Aerofax, Inc

AH-1W skid support arm fairing, similar to that found on other AH-1s, is aerodynamic in shape and optimized to lower aircraft drag during horizontal flight



Jay Miller/Aerofax, Inc

AH-1W empennage with its associated tail skid, ventral fin, and fairing for the left, rear quadrant AN/APR-39 radar warning antenna. Ventral fin provides additional area for improved directional stability at high angles of attack while also providing additional empennage protection during over-rotated takeoffs and landings.

Jay Miller/Aerofax, Inc

The tail skid, mounted in the aft end of the ventral fin, serves to protect the tail and tail rotor assembly from damage during landing and takeoff over-rotation

Jay Miller/Aerofax, Inc

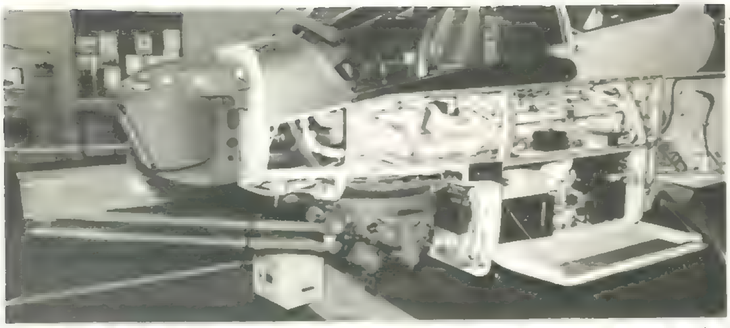
The number of easily removed panels in the AH-1S is sufficient to permit access to virtually every mechanical, hydraulic, or electrical part of the aircraft. The left side panels, visible in their open position, provide access to the ammunition magazine, various control system linkages, and the ammunition feed chute.

Jay Miller/Aerofax, Inc

The GEC M-143 low-speed, omni-directional air data sensor provides 3-dimensional airspeed, downwash, static pressure, and air temperature data.

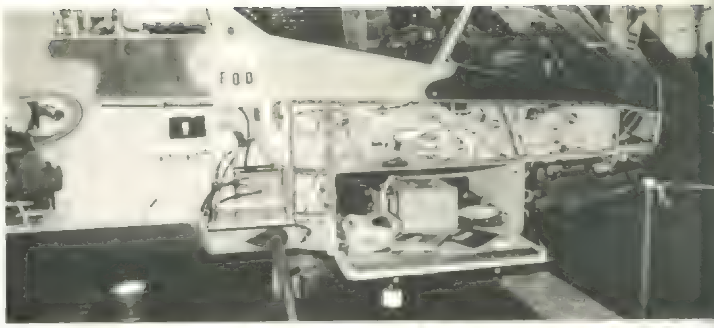
Jay Miller/Aerofax, Inc

Additional control system linkages, miscellaneous avionics, the ammunition magazine right side, and turret control system mechanicals all are accessed from the right side of the AH-1S. Bulge below right forward transparency provides hand clearance around cyclic control stick inside cockpit.

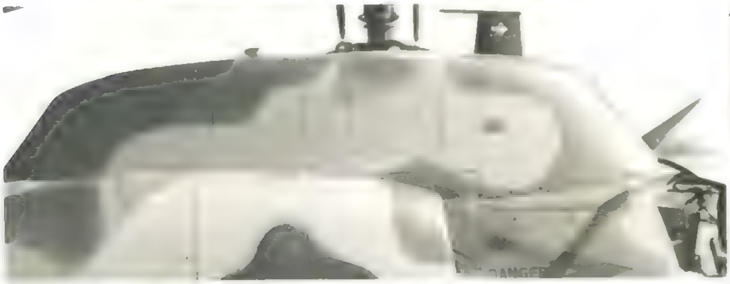


Jay Miller/Aerofax, Inc

The AH-1W, like its predecessor, is equipped with a plethora of removable side panels for easy access to internal equipment and systems. Ground maintenance is easily accomplished due to the height of the aircraft.



Almost all of the AH-1W's armored side paneling is designed to absorb hits by hostile ground fire. Materials such as Kevlar are utilized in the production process, thus permitting light weight and extraordinary strength.



Jay Miller/Aerofax, Inc

The AH-1W's rotor head fairing blends with the aircraft upper structure and considerably improves airflow in this high drag area. The AN/ARC-182 command antenna and AN/APX-100 IFF antenna are combined in the one blade antenna shown.

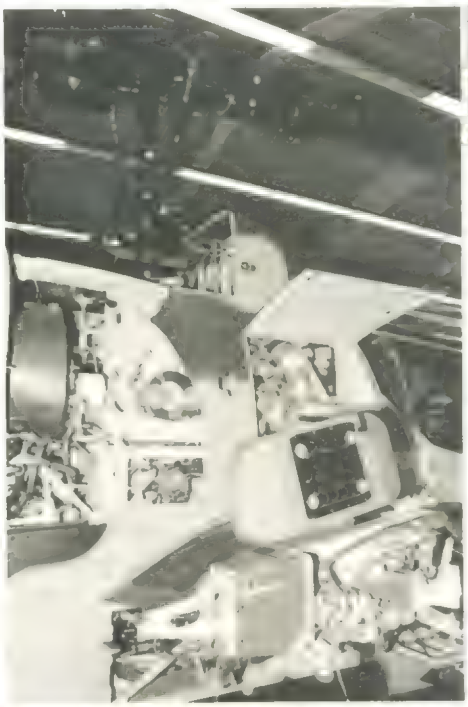
The AH-1W's rotor head fairing is equipped with two pylon access doors on each side. Additionally, when major maintenance is required, the entire assembly easily can be removed. Static pitot sensor is visible to the left.

Jay Miller/Aerofax, Inc

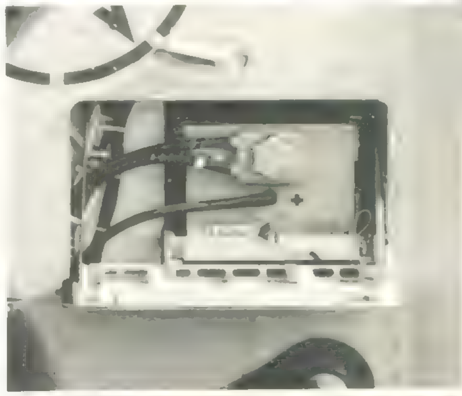
Crew and cockpit environmental control unit is mounted just aft of the cockpit and along with some avionics, is accessed from the left side of the aircraft.

The AH-1W's engine nacelles stretch aft of the rotor head fairing in order to accommodate the exhaust nozzle infrared cooling system and basic c.g. requirements. A pair of FM homing antennas are mounted on the top sides of the nacelles. Visible upper left is a standard red rotating beacon.

Jay Miller/Aerofax, Inc



Jay Miller/Aerofax, Inc



The AH-1W's battery is located in a small compartment just aft of the ammunition magazine bay. Access is from the right side.

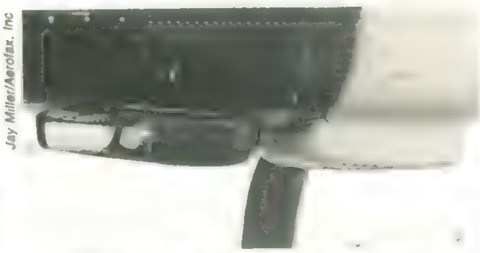
AH-1W center fuselage area, with its numerous powerplant, weapons, and controls sytems has been designed for easy accessibility. Primary engine transmission and related rotor head assemblies are located in this area. Accordingly, all paneling is made of fracture and penetration resistant materials.

AH-1S tail boom is accessed internally through removable panels. Miscellaneous control and armament system control computers are mounted inside.

Avionics bays are heavily concentrated in the aft main fuselage section of the AH-1W. A second AN/ARC-182 command and AN/APX-100 IFF combined antenna also is mounted ventrally in this area. To the right is the pressure refueling connector. Cooling intake accommodates avionics bay and miscellaneous requirements.

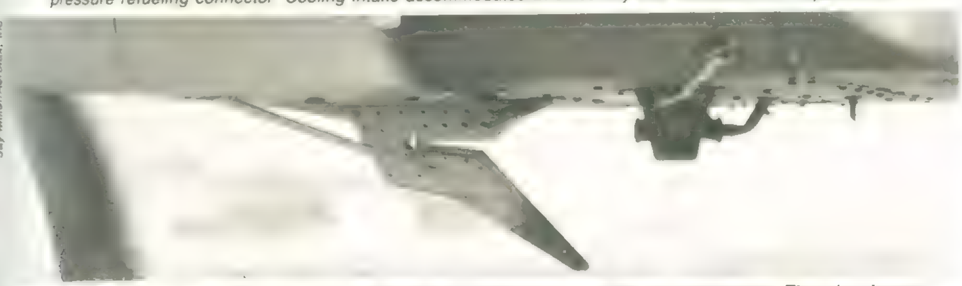
Jay Miller/Aerofax, Inc

Jay Miller/Aerofax, Inc

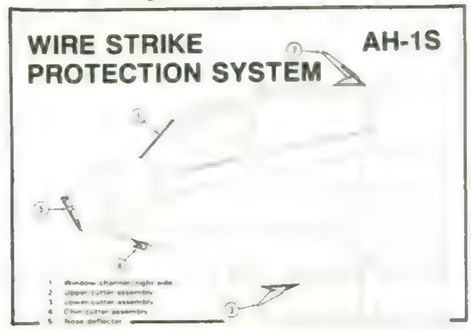


Blower air for the third hydraulic transmission is dumped via ventral exhaust port. Ahead of it is the DF-301 navigation system antenna fairing box.

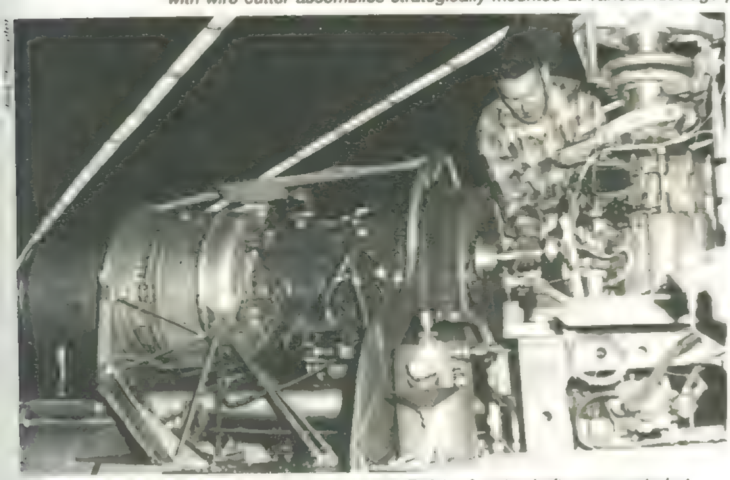
Jay Miller/Aerofax, Inc



Helicopters spend a significant part of their flight time operating in low altitude environments. Thus the chances of hitting tall, earthbound objects are high. Most AH-1s, such as this AH-1W, therefore are equipped with wire cutter assemblies strategically mounted at various fuselage positions.



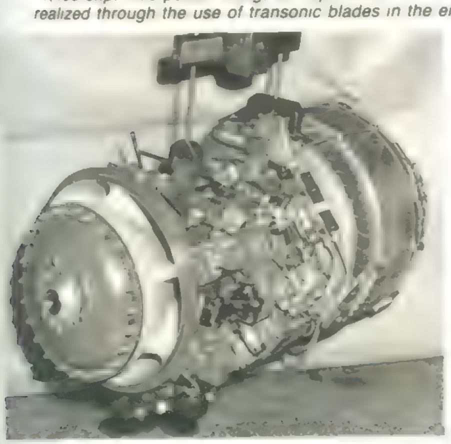
Jay Miller/Aerofax, Inc



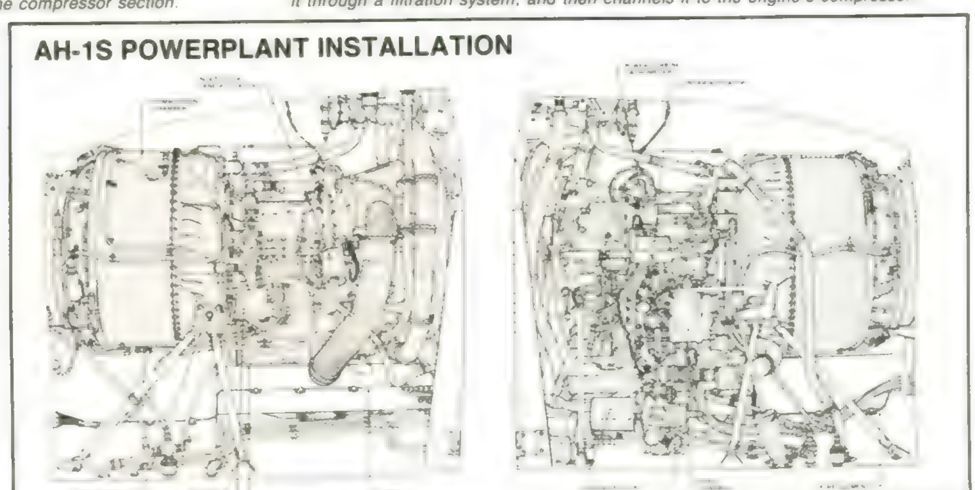
The AH-1G is powered by a single Lycoming T53-L-13 turboshaft engine rated at 1,400 shp. This power rating, an improvement over earlier T53 versions, was realized through the use of transonic blades in the engine compressor section.

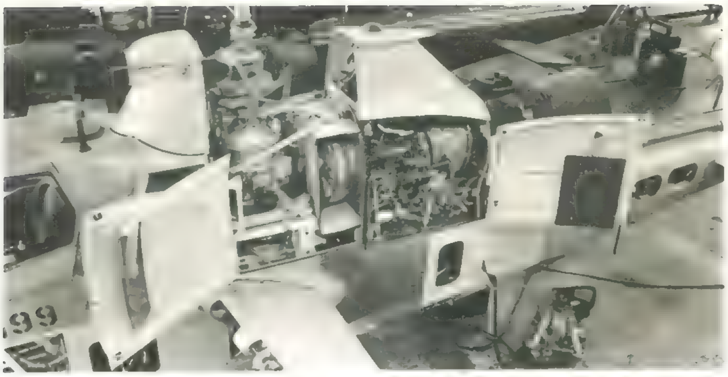
The AH-1S's 1,800 shp Lycoming T53-L-703 is faired cleanly behind the main rotor transmission. The bifurcated intake brings air in from both sides of the aircraft, runs it through a filtration system, and then channels it to the engine's compressor.

Bell Helicopter



Well in excess of 20,000 T53s have been built. It remains in production as of this writing. A T53-L-13 for the AH-1G is shown.

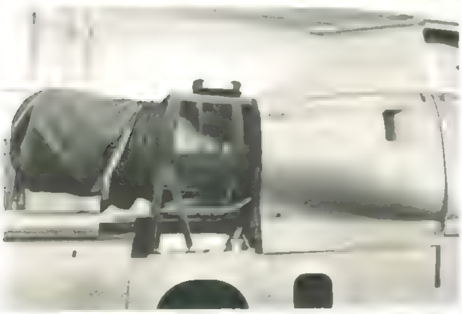




Jay Miller/Aerofax, Inc

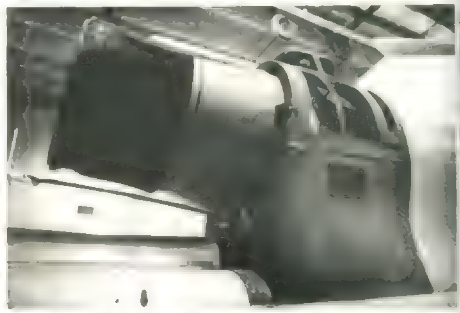
The AH-1S is powered by a single Lycoming T53-L-703 turboshaft engine rated at 1,800 shp. The weight increase over its predecessor is only 6 lbs. It is 47.6 in. long, 23 in. in diameter, and has a basic weight of 540 lbs.

The AH-1S's Lycoming T53-L-703 has a single-piece intake of annular design, a magnesium alloy casing with steel inserts, six radial struts to support the front main and reduction gearbox bearings, and hot bleed air anti-icing.



Jay Miller/Aerofax, Inc

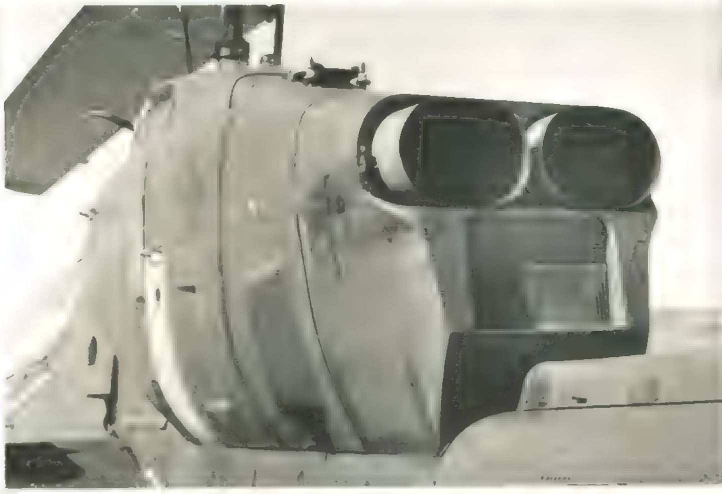
Jay Miller/Aerofax, Inc



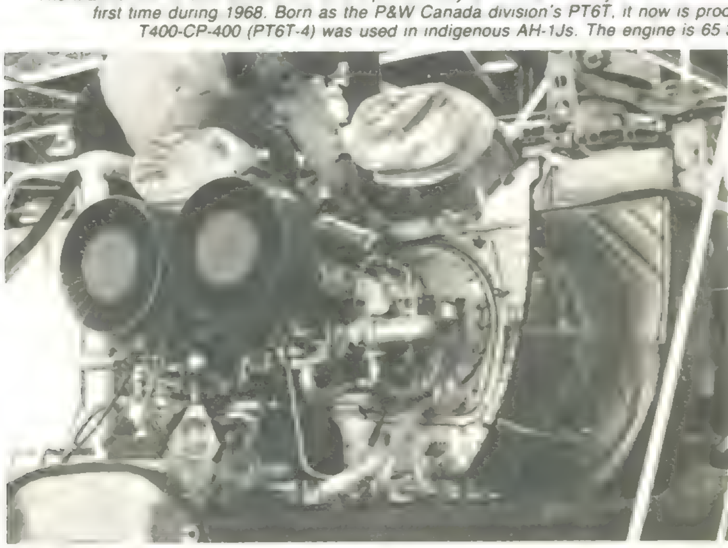
The Lycoming T53-L-703, as installed in the AH-1S, can be equipped with an optional intake inertial particle separator permitting operations in dusty environments.

In a concentrated effort to reduce the infrared signature of the AH-1S's T53 engine exhaust plume, Bell and Lycoming developed a distinctive extended exhaust nozzle that actively, through its circular fin design and exhaust nozzle plug configuration, dissipates heat through controlled radiation.

Ken Peoples



The Marine AH-1T and Iranian AH-1J are powered by a Pratt & Whitney T400-WV-402 "Twin-Pac" (PT6T-6). Created by mating two PT-6s to a common gearbox, it ran for the first time during 1968. Born as the P&W Canada division's PT6T, it now is produced for U.S. military aircraft in Bridgeport, W. Virginia. The same engine, as the T400-CP-400 (PT6T-4) was used in indigenous AH-1Js. The engine is 65.3 in. long, 43.5 in. wide, and 32.6 in. tall. The T400-WV-402 weighs 745 lbs.

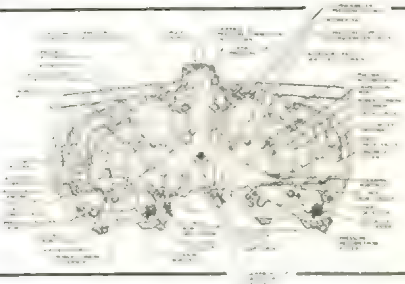


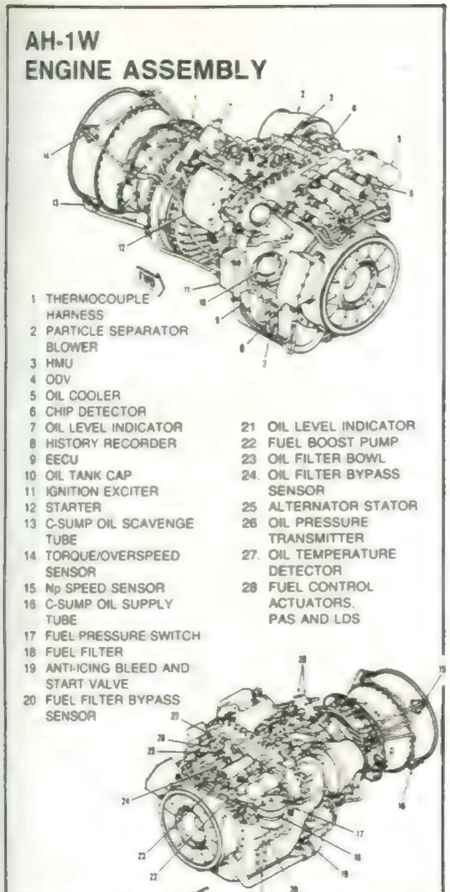
Bell Helicopter

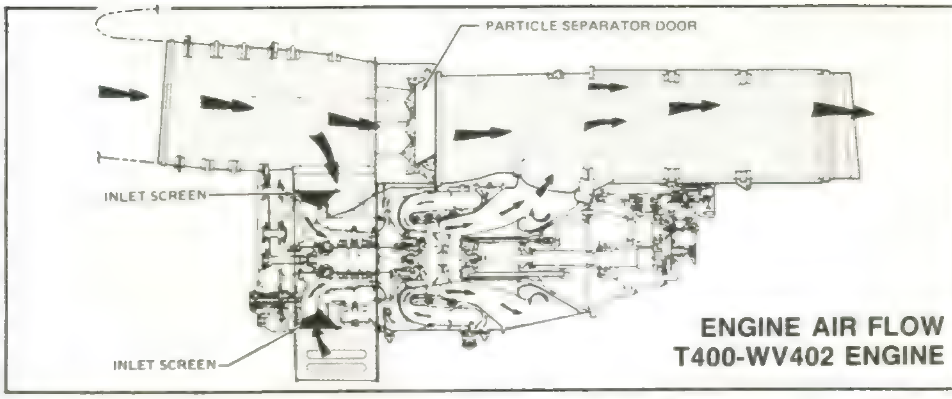
The AH-T's T400-WV-402 consists of twin PT-6s with independent air intakes, stainless-steel screened annular intakes with an alcohol-based de-icing system, and independent inertial partical separation systems similar to that found on the T53-L-703.

AH-1T ACCESSORY GEARBOX SECTIONS AND COMPONENTS

AH-1T *SLICK* AFT SECTIONS OF ENGINES COMBINING GEARBOX AND ACCESSORIES



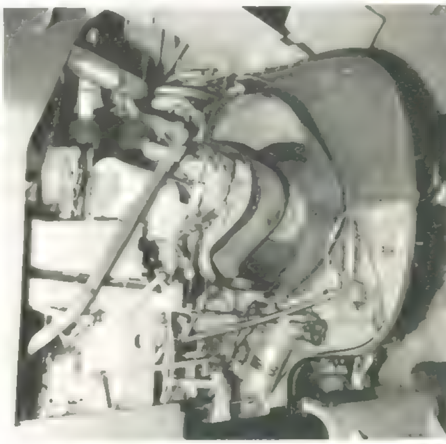




Jay Miller/Aerofax, Inc

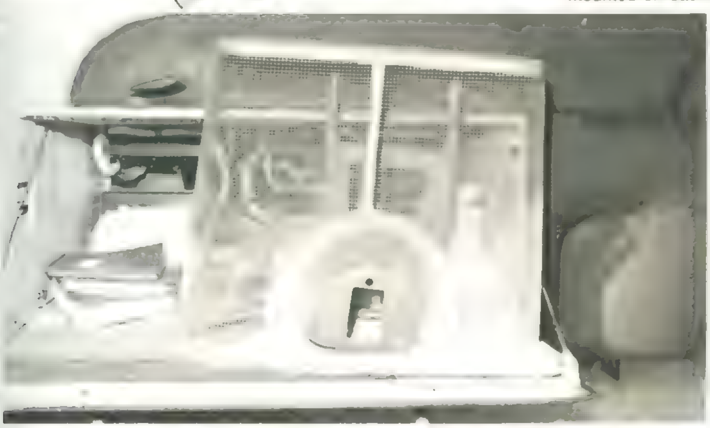
Each of the AH-1W's two General Electric T700-GE-401 turboshaft engines is fed air by a separate intake mounted on each side of the aircraft.

Jay Miller/Aerofax, Inc



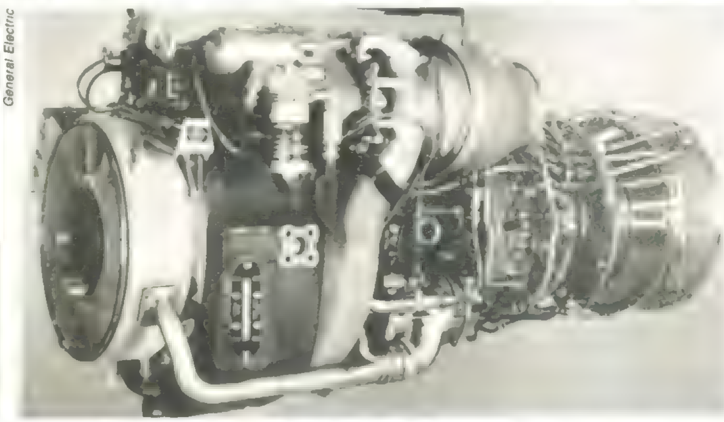
The T700's intake actually is routed around the engine's drive shaft. The latter is attached to a gearbox which delivers power from both engines to the rotor.

Jay Miller/Aerofax, Inc



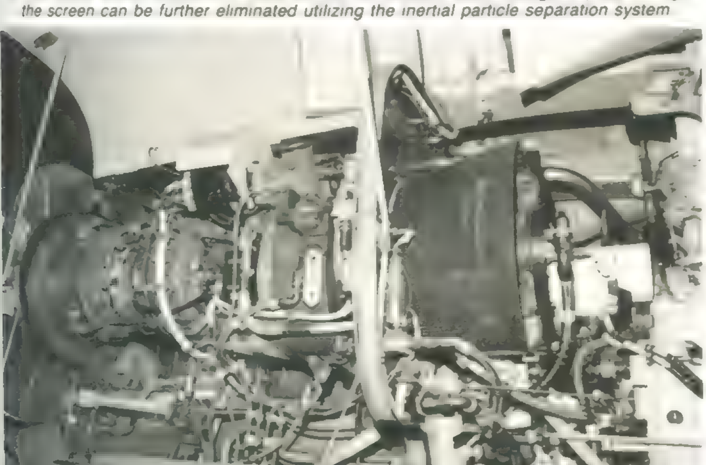
The AH-1W's engines are protected from foreign object damage by manually installing a wire mesh intake screen over each intake. Particulates small enough to pass through the screen can be further eliminated utilizing the inertial particle separation system.

General Electric

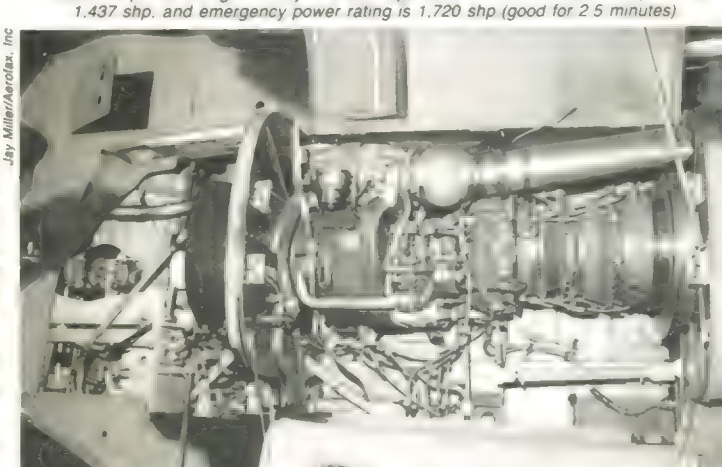


General Electric T700-GE-401 is equipped with an accessory package that sits topside. Maximum power rating normally is 1,693 shp; maximum continuous rated power is 1,437 shp, and emergency power rating is 1,720 shp (good for 2.5 minutes).

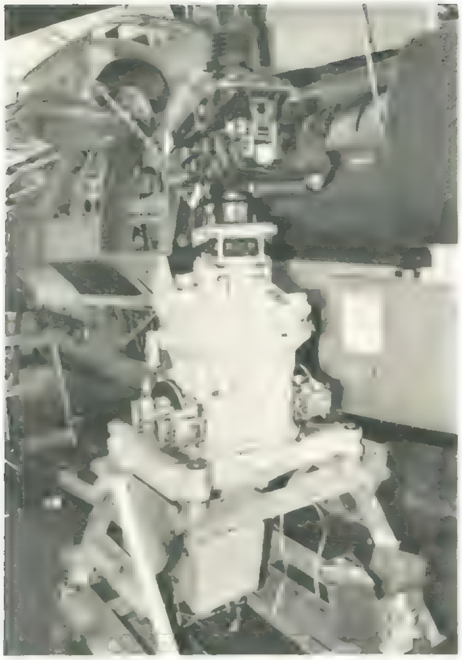
Jay Miller/Aerofax, Inc



Jay Miller/Aerofax, Inc

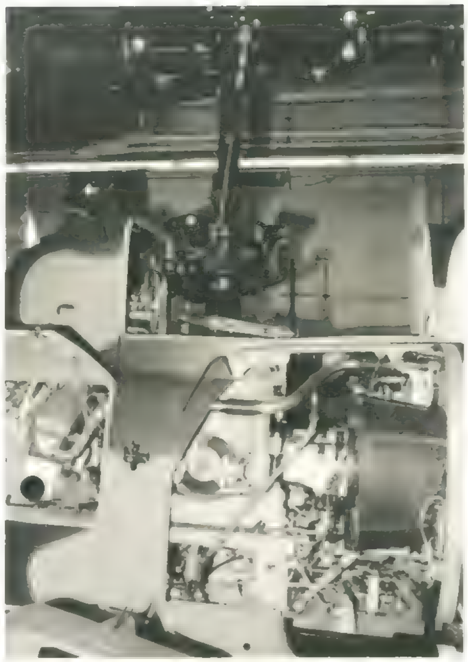


When installed in the AH-1W, the T700-GE-401 remains easily accessed via hinged paneling. The lower halves of this paneling serve as work stations for maintenance personnel. Excess room in each engine compartment helps facilitate maintenance. Additionally, because aligning features have been provided to external accessories, many field serviceable parts can be changed in less than ten minutes. The engine is unitized, thus permitting major components to be repaired without having to remove everything.



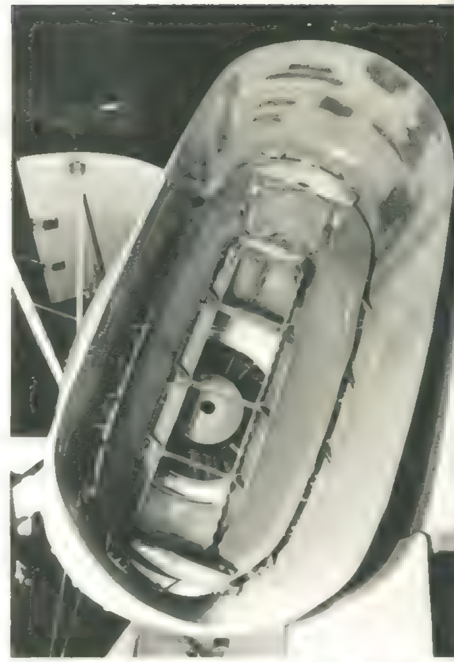
Jay Miller/Aerofax, Inc

The main AH-1W rotor transmission system sits ahead of and between the two T700-GE-401 engines and is driven by the gear train in the combining box.

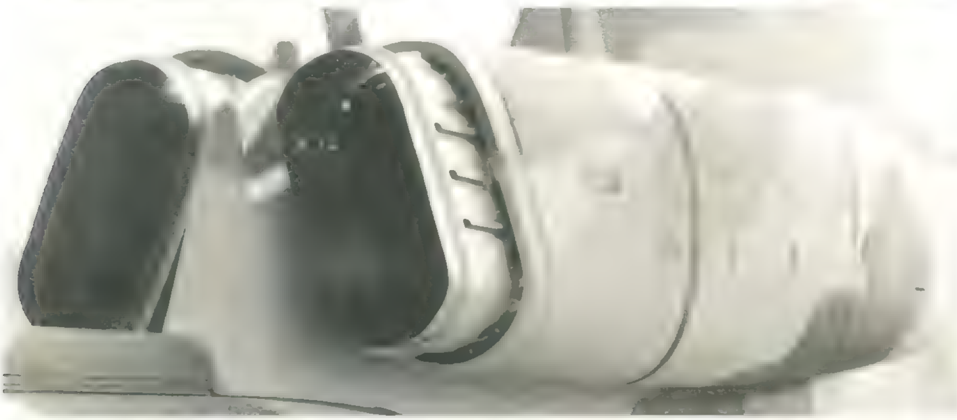


Jay Miller/Aerofax, Inc

AH-1W rotor brake (polished disk in lower center), permits rapid deceleration of rotor during combat situations when aircraft accessibility is time sensitive.



The AH-1W is equipped with special exhaust nozzles optimized to rapidly cool the exhaust efflux and thus lower the aircraft's infrared signature.

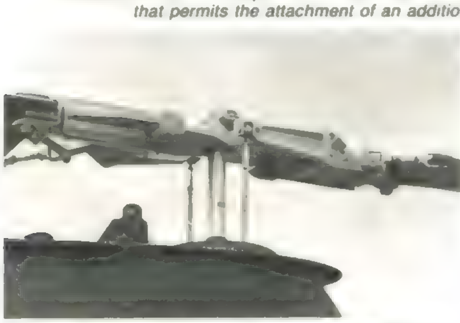


Jay Miller/Aerofax, Inc

The elongated, flattened oval exhaust nozzles extend well past the furthest aft portions of the engines, thus permitting exhaust heat to be dissipated in the most efficient and rapid way possible. A field modification is available that permits the attachment of an additional infrared lowering exhaust system extension.

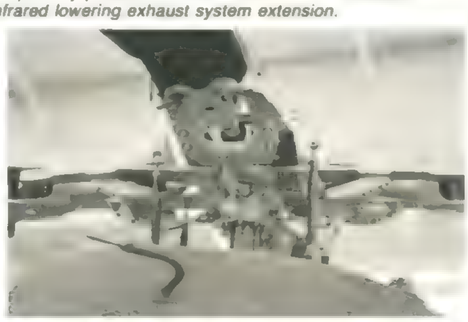
Jay Miller/Aerofax, Inc

The AH-1W's tail boom, which is removable for major maintenance, attaches to the main fuselage section at a point roughly in line with the exhaust nozzles.



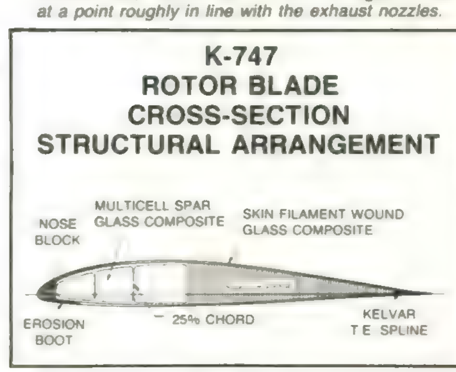
Jay Miller/Aerofax, Inc

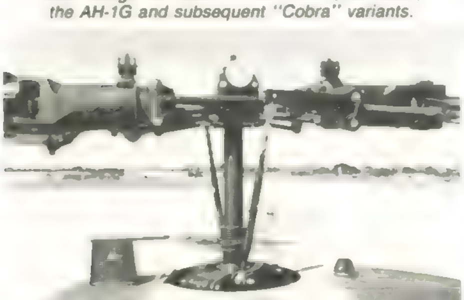
The AH-1S utilizes the Model 540 door-hinge rotor head design first used on the UH-1C, and later, the AH-1G and subsequent "Cobra" variants.



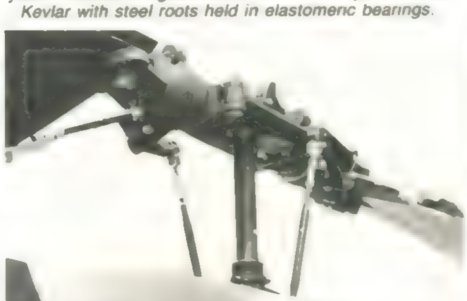
Jay Miller/Aerofax, Inc

Model 249 four-blade rotor has crossed, forged titanium yokes. Blades are glass fiber, Nomex honeycomb, and Kevlar with steel roots held in elastomeric bearings.





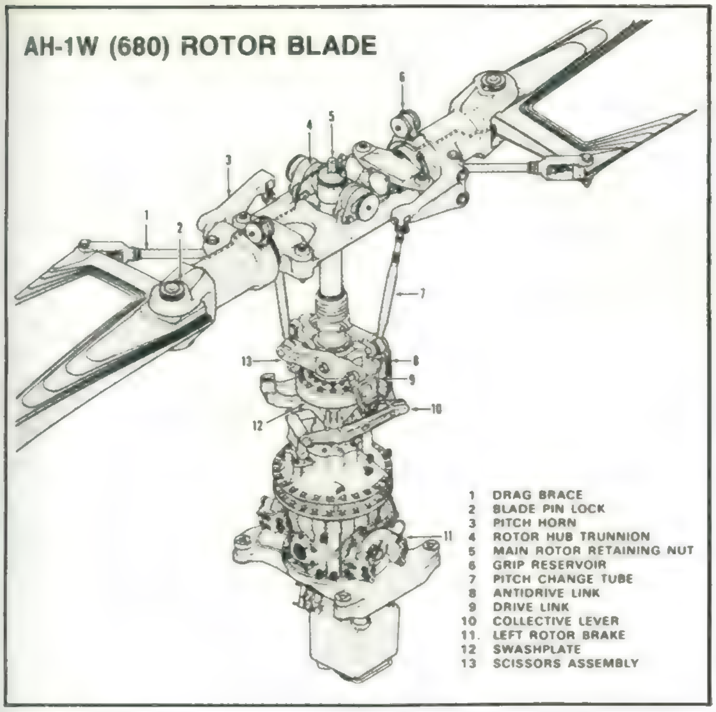
Jay Miller/Aerofax, Inc

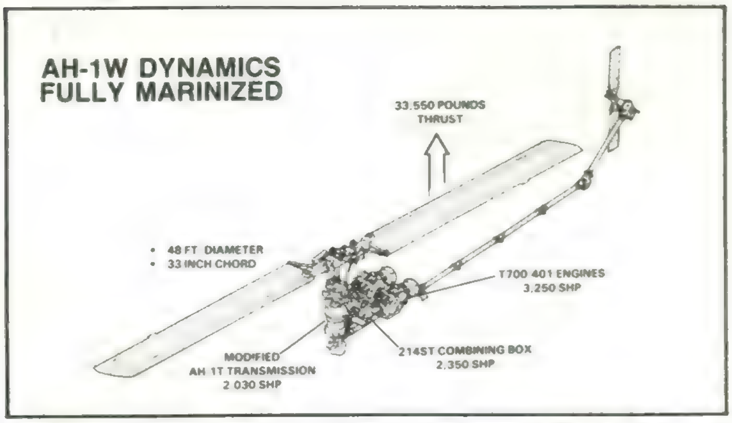


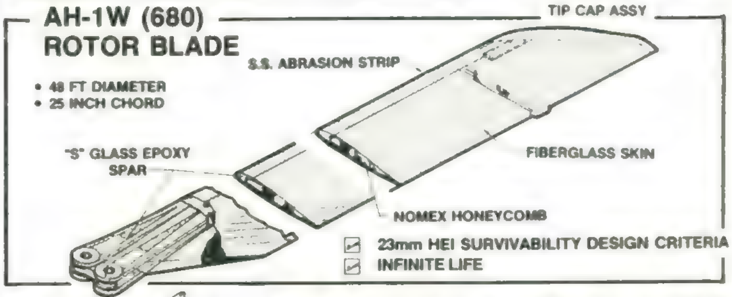
Jay Miller/Aerofax, Inc

Jay Miller/Aerofax, Inc

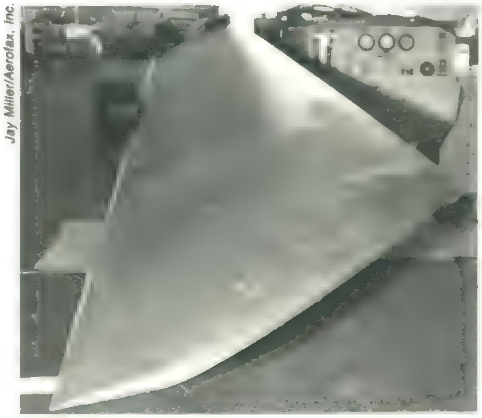
The AH-1W's main rotor is a developed version of the rotor utilized on the AH-1T, which in turn, was developed from the rotor used on the Bell Model 214. The hub, with Lord Kinematics Lastoflex elastomeric and Teflon-faced bearings, supports two, bonded, all-metal blades with a diameter of 48 ft. and a chord of 33 in. Rotor speed to engine rpm is slightly greater than 1:21 and the total thrust generated by the rotor can exceed 33,500 lbs.





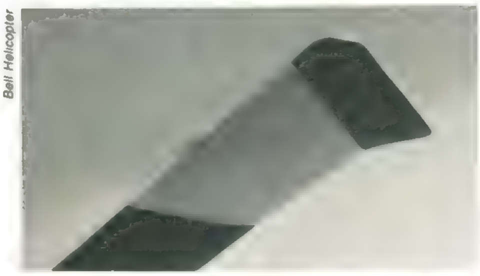


Jay Miller/Aerofax, Inc.



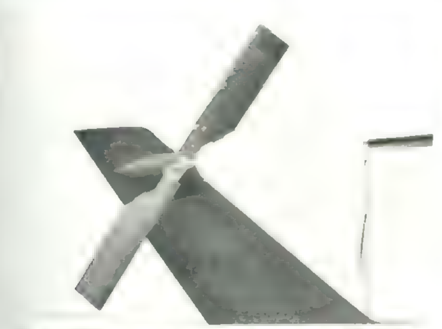
The AH-1W's rotor blade tips are swept in an attempt to reduce noise and improve the aircraft's performance in the high-speed segment of its flight envelope.

Bell Helicopter



Many different blade configurations and tips have been tested on the "Cobra". This swept tip seen on a broad chord rotor, was tested by Bell on an AH-1G.

Jay Miller/Aerofax, Inc.

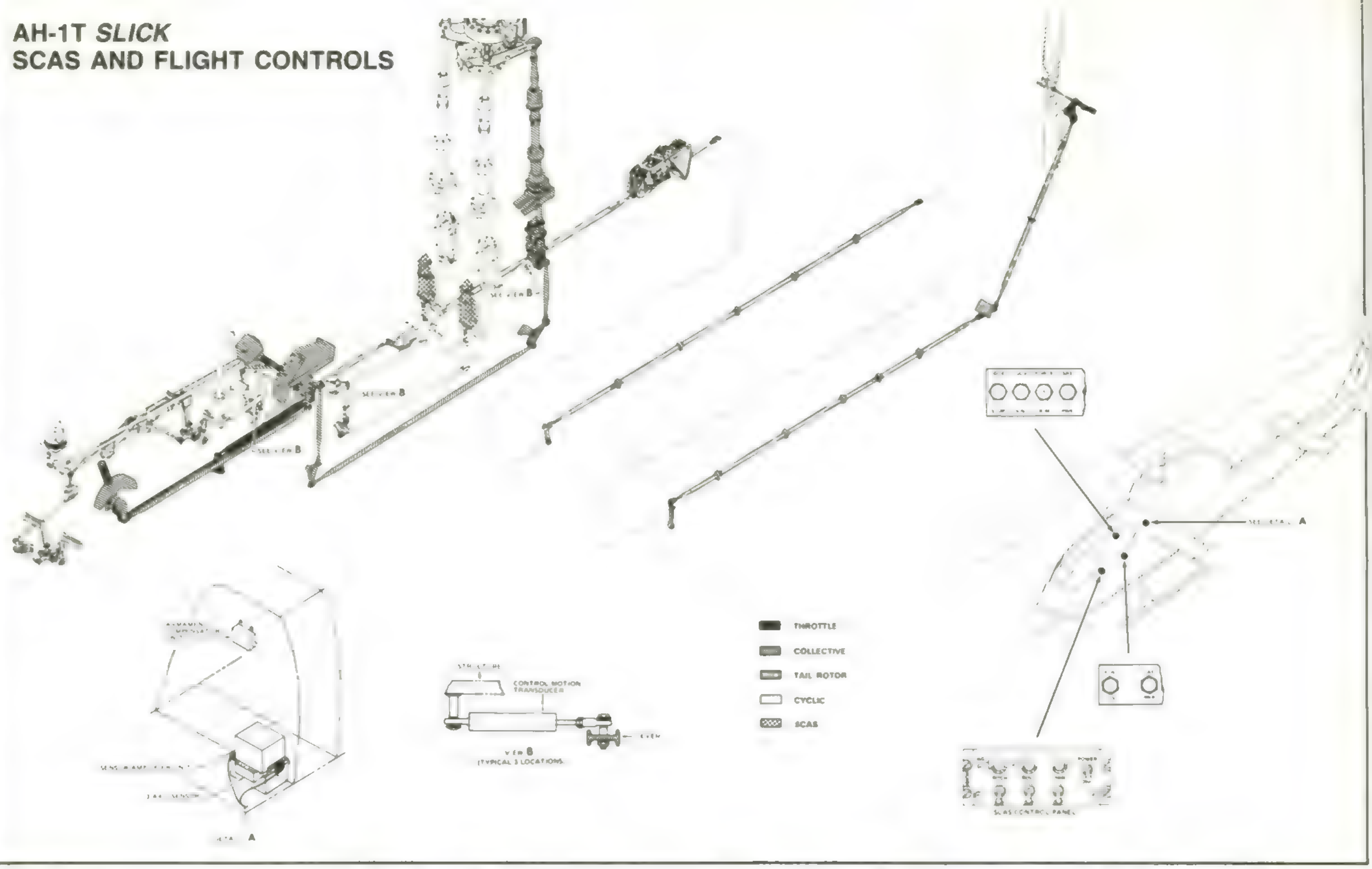


The AH-1G's tail rotor was moved from the left to the right side of the aircraft when it was discovered that directional stability was greatly improved by the change.

Jay Miller/Aerofax, Inc.

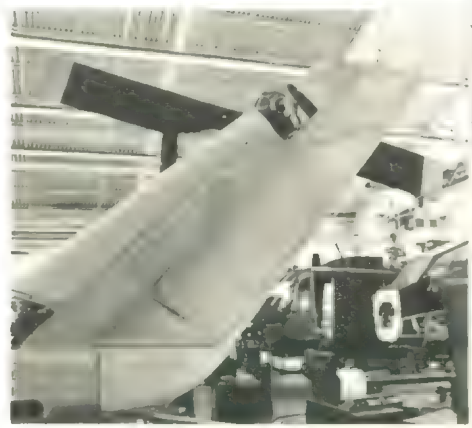
AH-1S tail rotor essentially is an upgraded version of the original configuration found on the first-generation AH-1Gs. Blade construction was metal skin with a honeycomb core. Tail rotor drive shaft was mounted in fin leading edge. Final drive right-angle gearbox is hidden inside teardrop fairing.

AH-1T *SLICK* SCAS AND FLIGHT CONTROLS



Jay Miller/Aerofax, Inc

Bevel drive gearbox is visible at the base of the fin leading edge. This unit is oil cooled and lubricated. A tail position light and an AN/APR-39 radar warning antenna fairing are visible (lower right) attached to the tail boom. The AN/APR-39 system consists of four sensors, with one mounted in each quadrant of the aircraft.

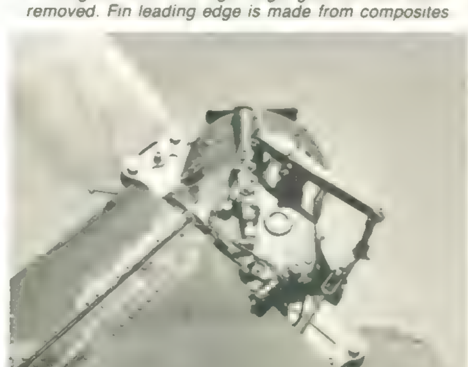


Jay Miller/Aerofax, Inc

Left side of AH-1S vertical fin assembly. Teardrop fairing for final drive right-angle gearbox has been removed. Fin leading edge is made from composites

Jay Miller/Aerofax, Inc

The tail rotor transmission shaft runs from the main rotor gearbox, aft to the bevel drive gearbox. Two large bearing assemblies hold the segmented shaft rigidly in position. Control linkages to the tail rotor are run through the tail boom assembly and up through the vetical fin to the tail rotor control mechanism.



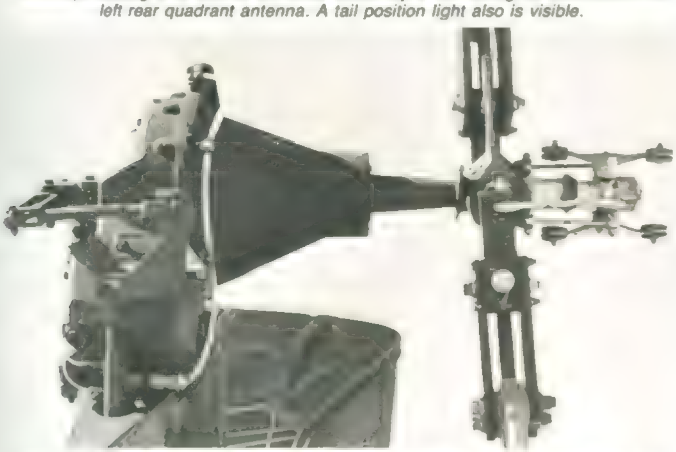
AH-1T tail rotor right angle gearbox has been left unfaired and exposed to the elements as a concession to its size and fin tip position.

AH-1T empennage mounts ventral fin, tail skid, and short, broad chord vertical tail. Visible protruding from the aft tail boom assembly is the fairing for the AN/APR-39 left rear quadrant antenna. A tail position light also is visible.

Jay Miller/Aerofax, Inc

AH-1W tail rotor drive shaft runs up the leading edge of the vertical fin. The bevel drive gearbox is located at the base of the leading edge and serves to transmit power from the tail rotor transmission shaft to the tail rotor.

Jay Miller/Aerofax, Inc



AH-1W tail rotor final drive right-angle gearbox is mounted at the extreme tip of the vertical fin assembly. The unit is oil cooled. Blade pitch changes are input through an actuator that runs through the center of the drive shaft.

Jay Miller/Aerofax, Inc.

Feathering counterweights are attached to the AH-1W's (and all "Cobras") blade pitch change assemblies to maintain the blades in neutral pitch when control inputs are removed. Unit appears to be complex, but in actuality is quite simple and reliable.

Jay Miller/Aerofax, Inc

Support/drive shaft of AH-1W tail rotor is hollow. Control inputs are delivered through a series of push-pull tubes, associated hinge assemblies, and the actuator that runs through the drive shaft. As the actuator moves through the shaft, it changes the blade pitch angles with great accuracy.

Jay Miller/Aerofax, Inc

Though resembling that of the AH-1T, the AH-1W's tail rotor is a relatively new design utilizing state-of-the-art materials and an improved rotor head assembly.

AH-1W SYSTEM CAPACITIES

System	Capacity (US) Usable	Unusable	Total
Fuel			
Total (Internal)	298 gal.	6 gal.	304 gal.
Oil			**Total**
Engine No. 1	3.8 qts.	3.5 qts.	7.3 qts.
Engine No. 2	3.8 qts.	3.5 qts.	7.3 qts.
Combining Gearbox Including Cooler	14 qts.	6 qts.	20 qts
Transmission Including Cooler	16 qts.	4 qts.	20 qts.
Intermediate Gearbox	3.5 pts.	–	3.5 pts.
Tail Rotor Gearbox	4.5 pts.	–	4.5 pts.
Main Rotor Hub Grip No.1	2.5 pts.	–	2.5 pts.
Main Rotor Hub Grip No.2	2.5 pts.	–	2.5 pts.
Hydraulic			
System No. 1	9 pts.	–	9 pts.
System No. 2	15 pts.	–	15 pts.
Utility System	3 pts.	–	3 pts.
VSS Accumulator	2000 ± 100 psi (Hydraulic System Off)	–	–

AH-1T SYSTEM CAPACITIES

System	Capacities Available	Unusable	Total
Fuel			
Forward Fuel Cell	190 gal		
Aft Fuel Cell	123 gal.		
	313 gal.	2 gal	
Right Wing Tank	100 gal	0.42 gal	
Left Wing Tank	100 gal.	1 15 gal	
	515 gal.	3.57 gal	
Oil			**Total**
Engine Section 1	3 qts.	3 4 qts.	6.4 qts
Engine Section 2	3 qts.	3.4 qts.	6 4 qts
Combining Gearbox	1 qt.	4 qts.	5 qts
Transmission	15.5 qts.	0*	18 5 qts
Intermediate Gearbox	3.5 pts.		3 5 pts
Tail Rotor Gearbox	4.5 pts.		4 5 pts
Main Rotor Hub Grip No.1	2 qts.		2 qts
Main Rotor Hub Grip No.2	2 qts.		2 qts
Hydraulic			
System No. 1	9 pts.		
System No. 2	11 pts.		

*Transmission oil cooler circuit contains an additional 3 qts. which is to be considered unusable

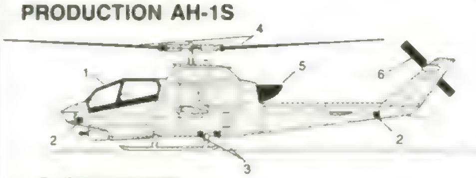
AH-1T *SLICK* SYSTEM CAPACITIES

System	Capacities Available	Unusable	Total
Fuel			
Forward Fuel Cell	190 gal.		
Aft Fuel Cell	123 gal		
	313 gal.	2 gal	
Right Wing Tank	100 gal	0 42 gal	
Left Wing Tank	100 gal.	1.15 gal	
	513 gal.	3.57 gal.	
Oil			**Total**
Engine Section 1	3 qts.	3.4 qts.	6 4 qts
Engine Section 2	3 qts.	3.4 qts	6.4 qts
Combining Gearbox	1 qt.	4 qts	5 qts
Transmission	15.5 qts.	0*	
Intermediate Gearbox	3.5 pts.		3 5 pts
Tail Rotor Gearbox	3.5 pts.		3 5 pts
Main Rotor Hub Grip No.1	2 qts		2 qts
Main Rotor Hub Grip No.2	2 qts.		2 qts
Hydraulic			
System No. 1	9 pts.		
System No. 2	11 pts.		

*Transmission oil cooler circuit contains an additional 3 qts which is to be considered unusable

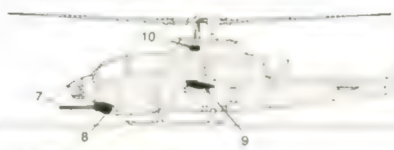
AH-1S UPGRADES

PRODUCTION AH-1S



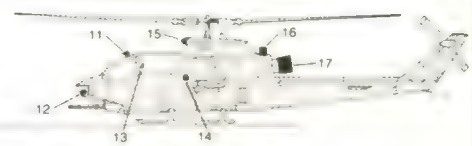
1 FLAT PLATE CANOPY
2 RADAR WARNING ANTENNA
3 RADAR ALTIMETER ANTENNAS
4 IMPROVED MAIN ROTOR BLADES (67TH AH-1S AND FOLLOWING)
5 INTERIM IR SUPPRESSOR
6 FLEX-BEAM TAIL ROTOR

UP-GUN AH-1S



7 M-197 20MM CANNON
8 UNIVERSAL TURRET
9 WING STORES MANAGEMENT SYSTEM
10 10 kVA GENERATOR/ALTERNATOR

MODERNIZED AH-1S



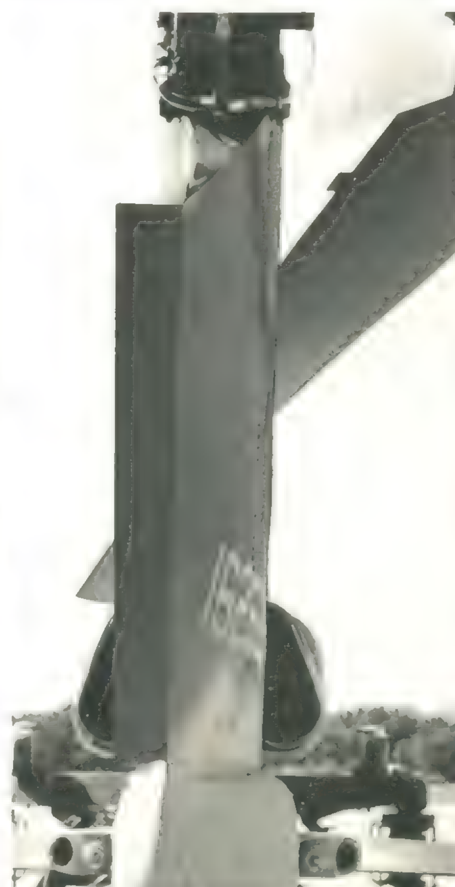
11 AIR DATA SENSOR (RIGHT SIDE)
12 LASER RANGE FINDER
13 HEAD-UP DISPLAY
14 SINGLE POINT REFUELING SYSTEM
15 AN/AAS-32 LASER TRACKER
16 AN/ALQ-144 IR JAMMER
17 IMPROVED IR SUPPRESSOR

Jay Miller/Aerofax, Inc

The original AH-1G elevator had a span of 6 ft. 2 in. Starting with the AH-1Q and the AH-1J, a new elevator was developed with a span of 6 ft. 11 in. This later became the standard elevator utilized on all subsequent "Cobra" variants, including the AH-1S, shown. Hand-hold-appearing VOR navigation antenna is visible to the left.

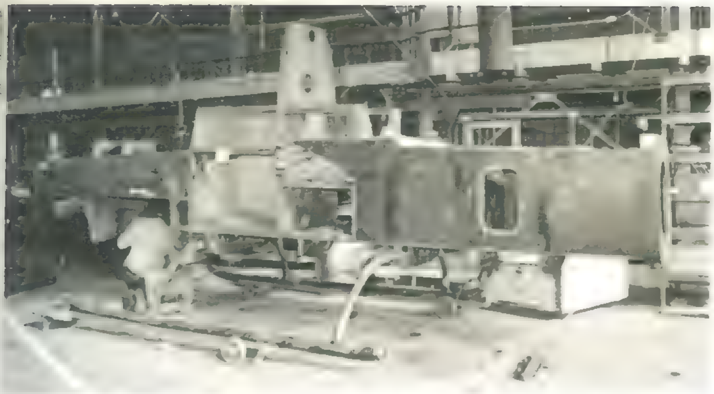
Jay Miller/Aerofax, Inc

The all-metal elevator (in helicopters, even though it is an all-moving surface, and thus technically a stabilator, it is referred to as an elevator) is a single-piece, all-moving unit that improves pitch, trim, and stability control. It is mechanically actuated with no boost. All "Cobras" are elevator equipped.



Jay Miller/Aerofax, Inc

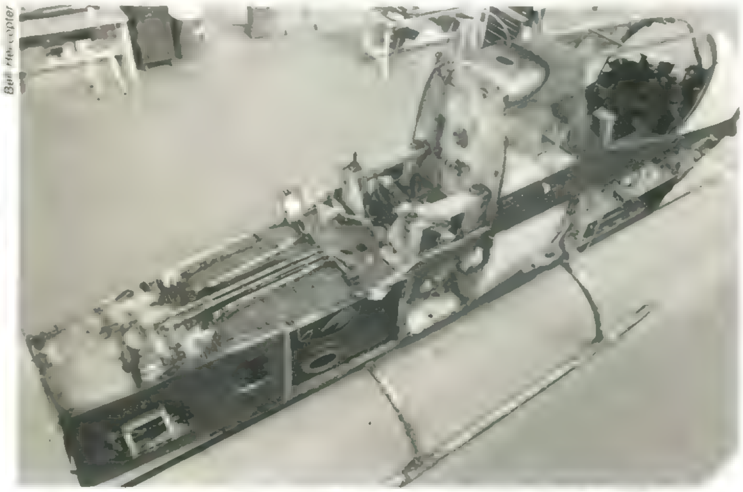
To offset torque-induced yaw, the AH-1W's vertical fin has built-in camber and an angled trailing edge flat plate surface.



An AH-1S is stripped to its most basic components during the course of a modernization program conducted for the Army at Bell's Amarillo, Texas facility. Most early AH-1Ss and upgraded AH-1Qs went through this procedure.

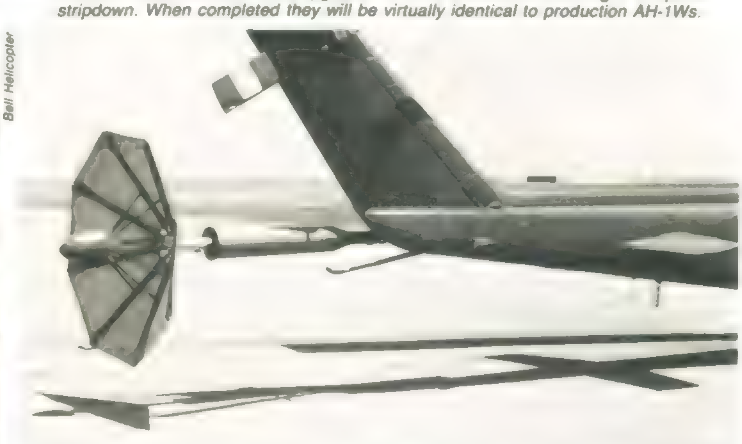
A group of AH-1G/Qs is seen during the course of the Bell upgrade program to AH-1S configuration. Distinctive blended canopy and engine bay optimized for single powerplant distinguish these aircraft from their stablemates.

The AH-1S (Modernized) program required an extensive rebuild of the entire helicopter. Only the most basic airframe components were utilized and many of the original panels and miscellaneous systems were either remanufactured or discarded.

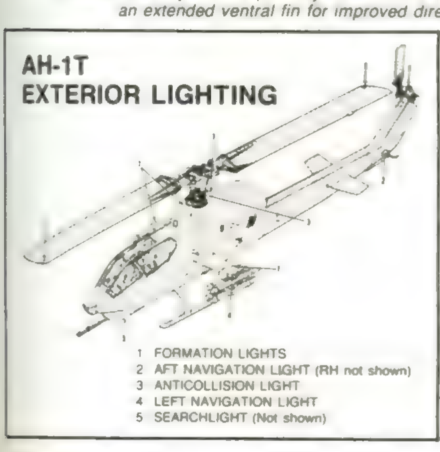


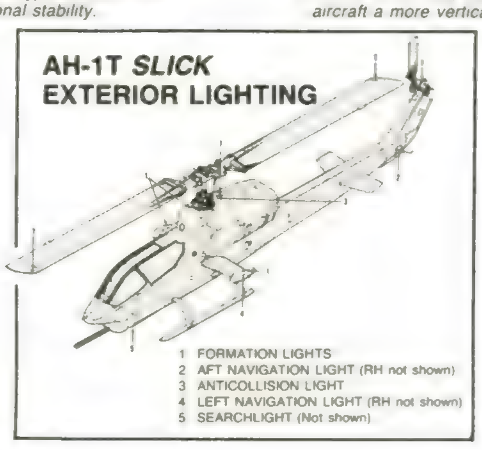
The Marines have evolved an AH-1T upgrade program similar to that for the Army's AH-1Ss. These aircraft will be upgraded to AH-1W standard following a complete stripdown. When completed they will be virtually identical to production AH-1Ws.

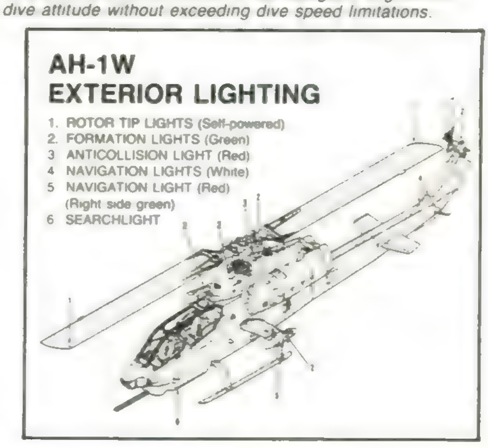
There have been a variety of ventral fin configurations tested on the various "Cobra" models. An early AH-1G, possibly the Model 209 prototype, is seen with an extended ventral fin for improved directional stability.

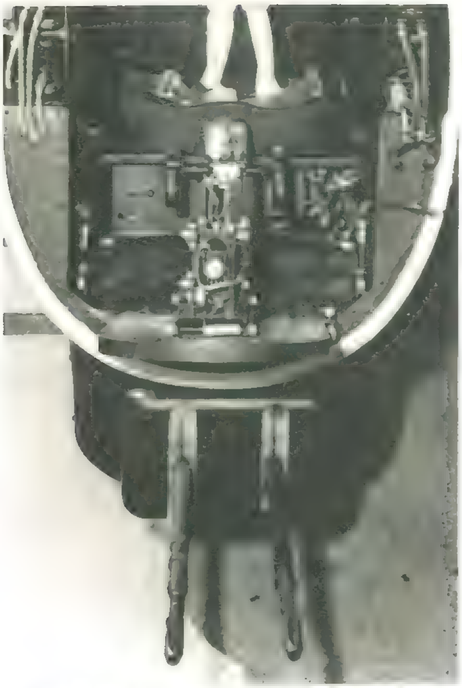


A deceleration-type airbrake unit, configured physically and designed to open like an umbrella in reverse, was tested on AH-1G, 67-15489. It was designed to give the aircraft a more vertical dive attitude without exceeding dive speed limitations.



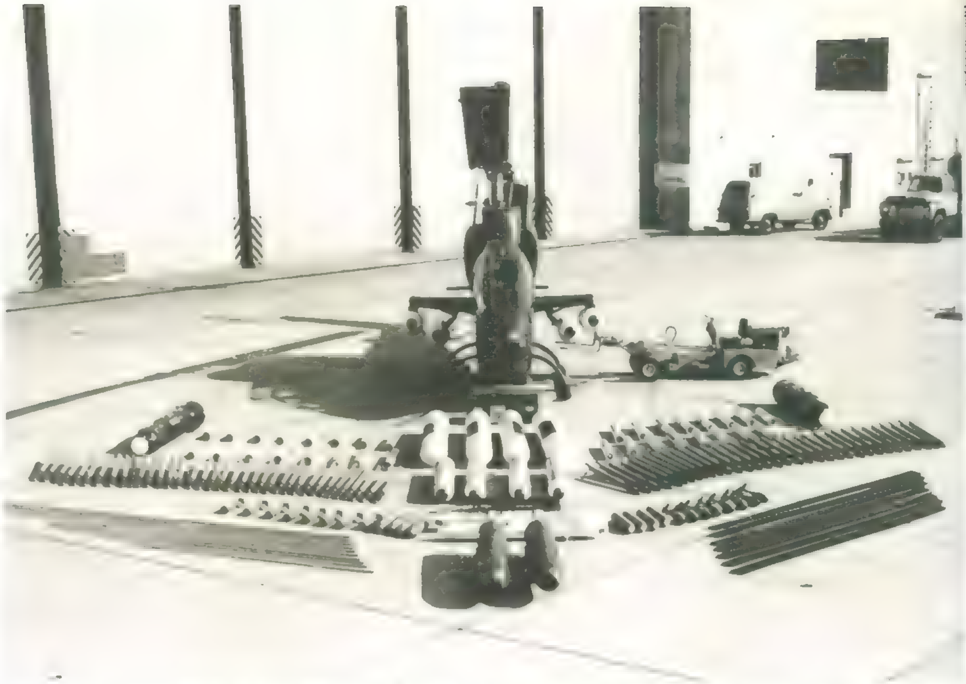






Bell Helicopter

The original Model 207 "Sioux Scout" privately funded Emerson Electric TAT-101 turret with its twin 7.62mm M-60C machine guns.



Bell Helicopter

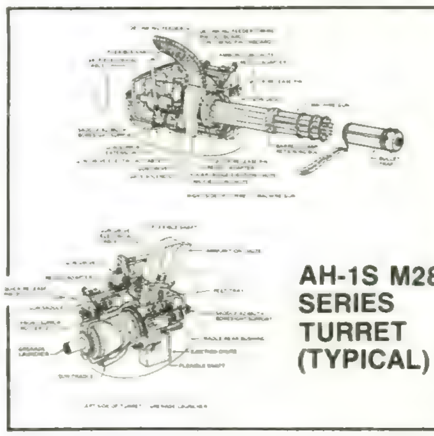
An AH-1T "Slick" set up to photographically illustrate the full spectrum of its armament options. Virtually all of the weapons shown, which include bombs, rockets, and gun pods, are optimized to be carried on the AH-1T's stub-wing pylons. A variety of other weapons later were cleared for use with the AH-1T.

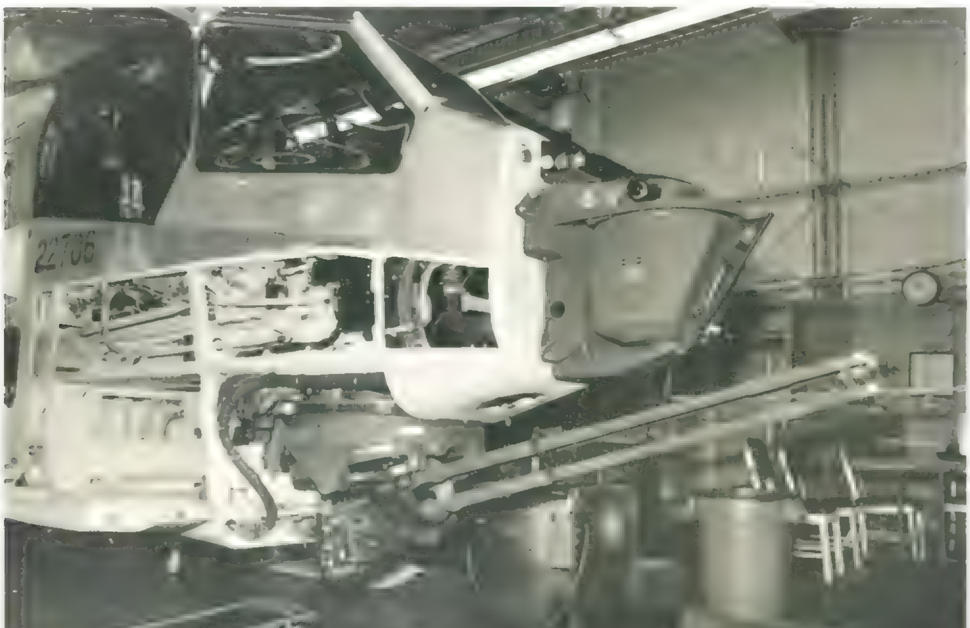
Bell Helicopter

The AH-1G's Emerson Electric TAT-102 chin turret could mount either twin 7.62mm rotary guns, twin 40mm grenade launchers, or a combination of both.

Hughes

Hughes developed "Cobra-Nite" system is optimized to permit TOW, cannon, and rocket operations in darkness, smoke, haze, and adverse weather.





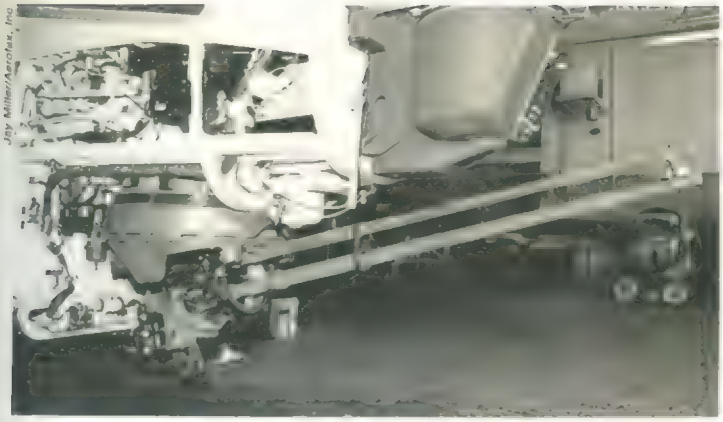
Jay Miller/Aerofax, Inc

The AH-1S is equipped with the Hughes developed LAAT sight based on the M65 TSU. It incorporates a laser rangefinder with a transmitter output of 40 millijoules. The transmitter operates at 4 pulses per second. Tube lifetime is approximately 1 million flashes. Beam divergence is .5 millirad and range is approximately 10km.

Bell Helicopter

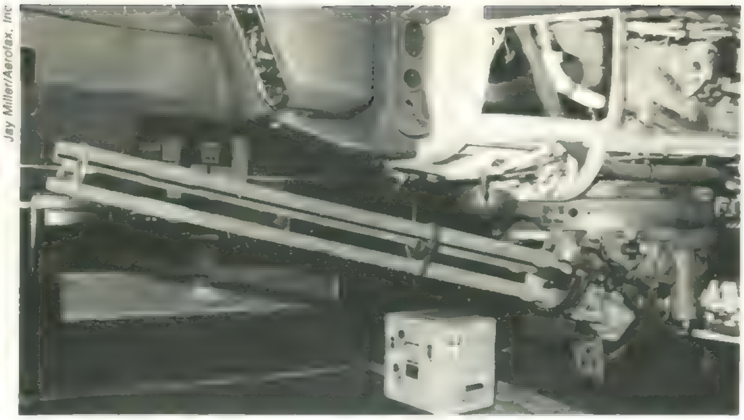
The Model 309 "KingCobra" was equipped with an early, first generation TSU optimized to serve the needs of both cannon and TOW missiles.

Jay Miller/Aerofax, Inc



The AH-1W's GE universal turret is equipped with a 20mm M197 rotary cannon. Two electic motors drive the turret in azimuth and elevation via reduction gearing. Control is either by aiming signals from the crew member helmet sights, or from the TSU

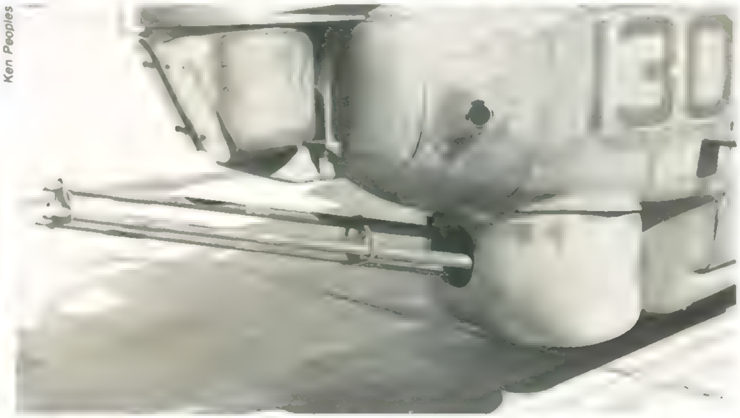
Jay Miller/Aerofax, Inc



The 20mm M197 rotary cannon has a firing rate of between 680 and 780 rpm. The nominal firing rate is 730 rpm and maximum recoil force is approximately 1,150 lbs Linked 20mm ammunition is delivered from the magazine via a small booster motor.

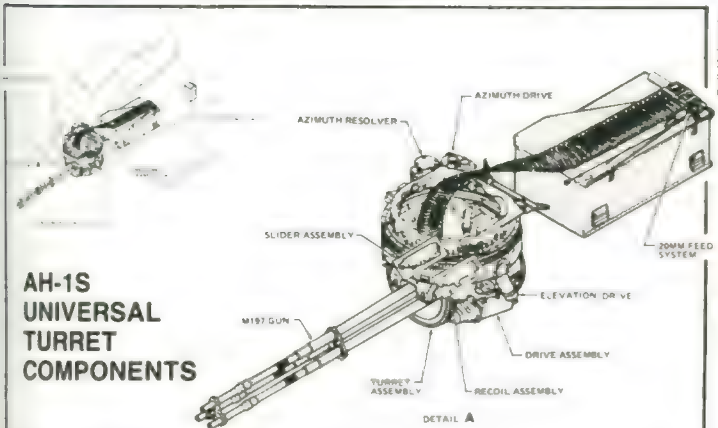
The AH-1W's turret can be slewed up to 110° away from the aircraft's centerline, and has limitations of 20.5° in elevation and 50° in depression. The Ah-1W's gun can use depleted uranium/tungsten alloy APDS qualified for anti-armor missions.

Ken Peoples

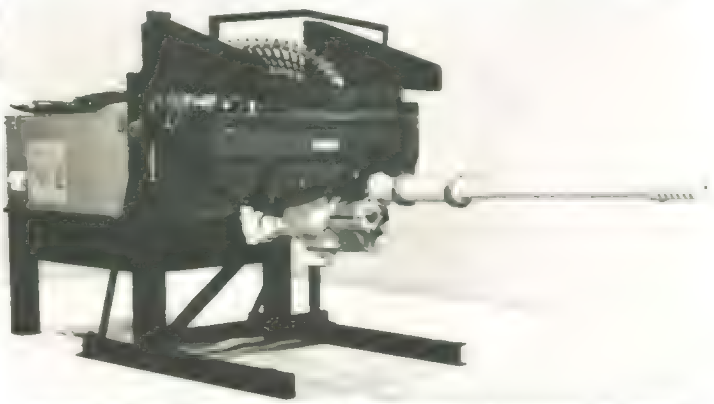


The AH-1T's turret is equipped with the same GE 20mm M197 rotary gun that later was utilized in the AH-1W's turret. This unit earlier had been developed for use in the AH-1S ECAP turret configuration. All AH-1Ss are M197 rotary gun equipped.

AH-1S UNIVERSAL TURRET COMPONENTS

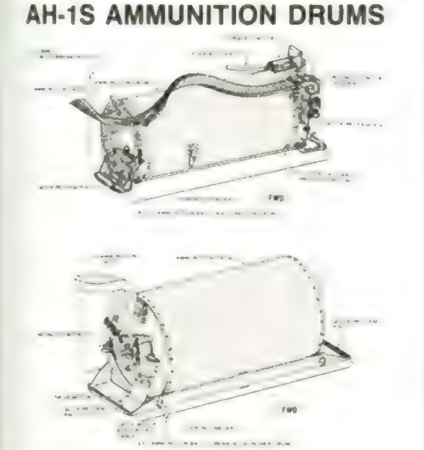


Bell Helicopter

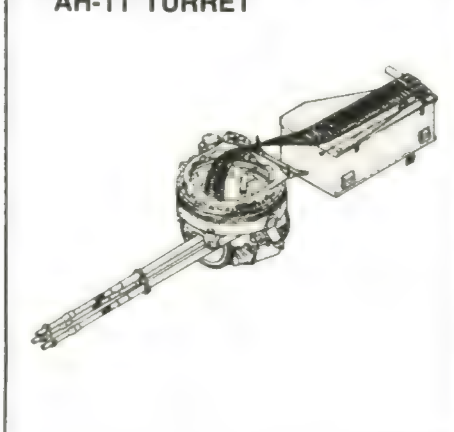


Mock-up of M230 "Chain Gun" turret assembly originally intended as an optional installation on the AH-1S. The extraordinary success and dependability of the M197 unit effectively killed the M230's "Cobra" possibilities.

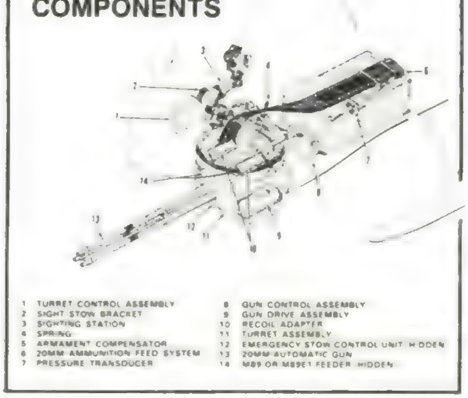
AH-1S AMMUNITION DRUMS



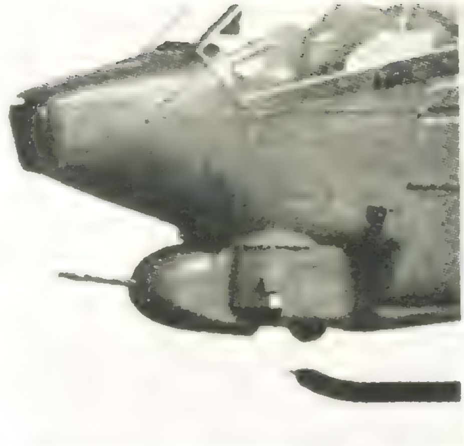
AH-1T TURRET



AH-1T *SLICK* 20MM SUBSYSTEM COMPONENTS

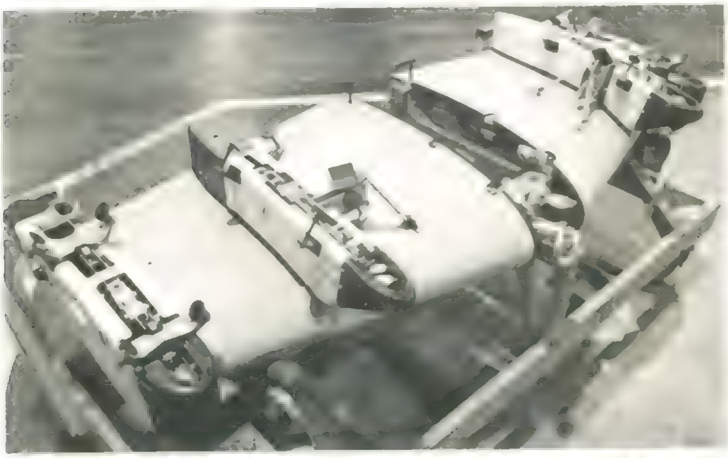


Emerson Electric



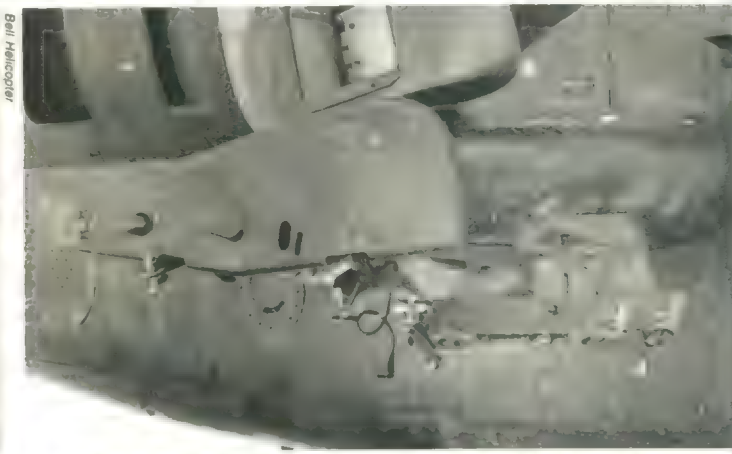
Bell Helicopter

Various turret configurations have been tested, and in some cases utilized, on various versions of the "Cobra". Among these have been (l. to r.) the M28 turret on the AH-1G/Q equipped with two GAU-28/A rotary barrel "Miniguns" firing 7.62mm rifle-caliber cartridges, an experimental turret equipped with a single-barrel 7.62mm "Minigun" (same as the equipment found on the original Model 207), and the AGES system which is designed to provide realistic gunnery training without the use of actual ammunition.

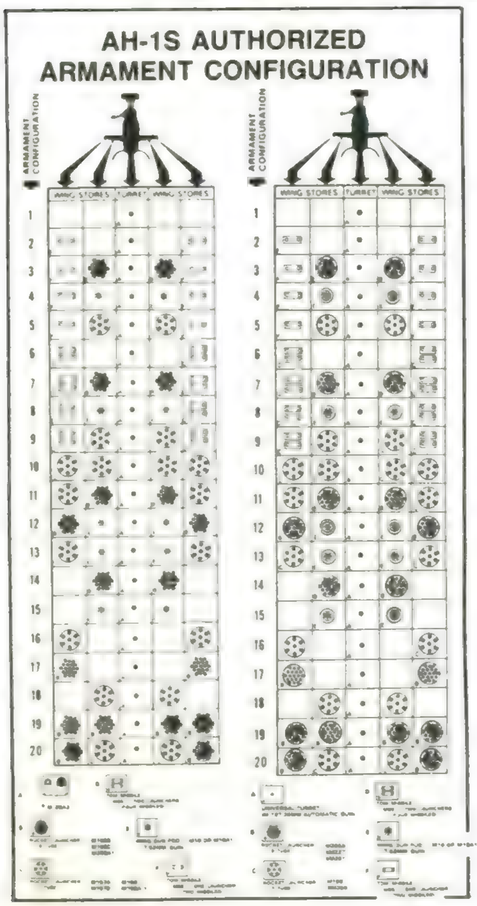


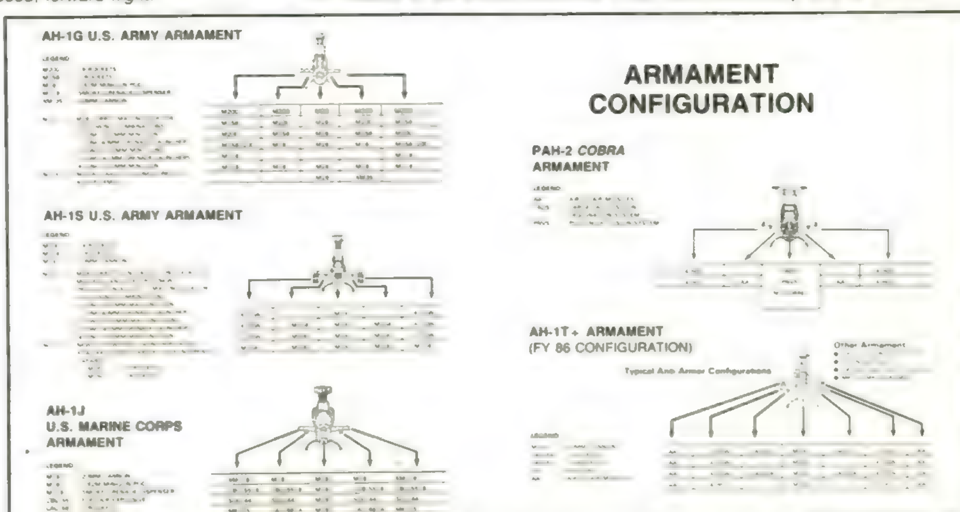
Bell Helicopter

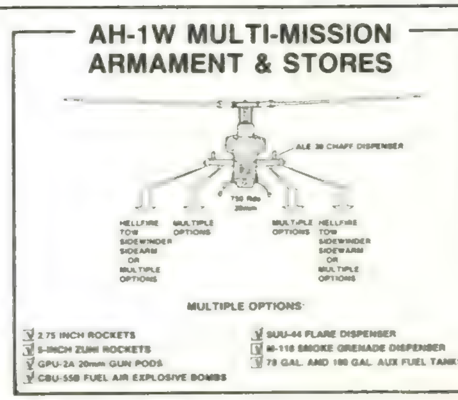
The stub-wings of the AH-1S (seen with lower surfaces facing up) are pylon equipped and optimized to carry a wide variety of external stores and weapons. Aerodynamic in shape, they generate contributory lift during high-speed, forward flight.

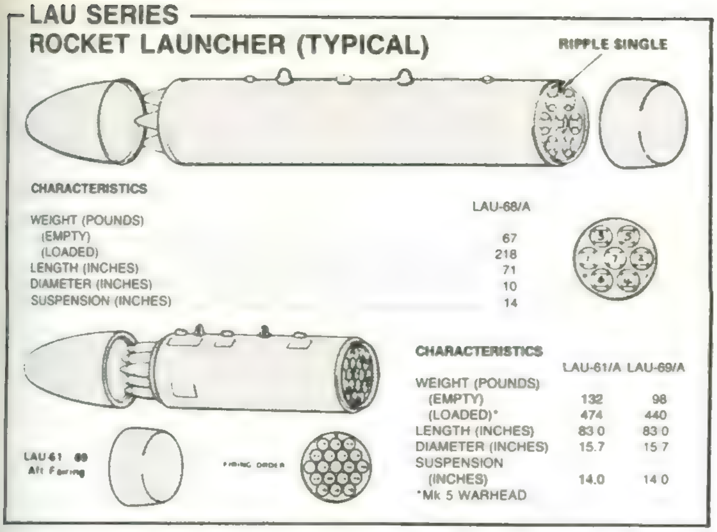


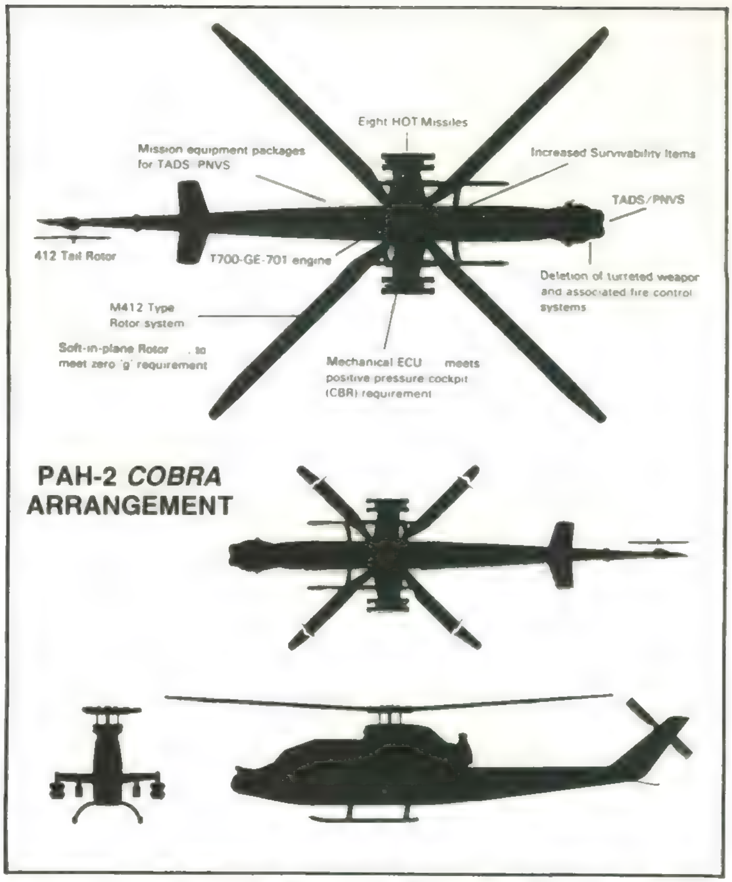
The stub-wings of the AH-1T are equipped with tip pylons that contain hydraulic actuators which allow TOW tubes to be moved in elevation between +7° and −5° relative to the aircraft centerline. When deactivated, they stow at +4°.

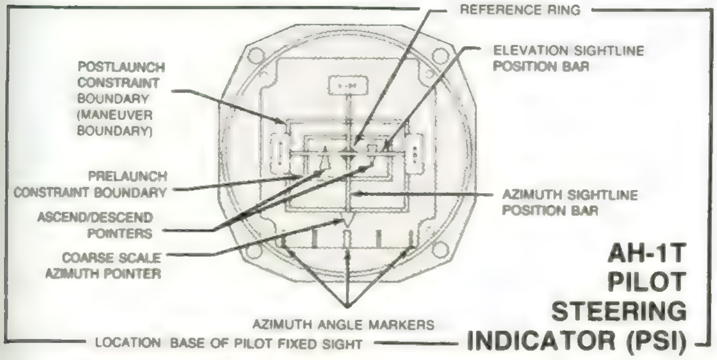








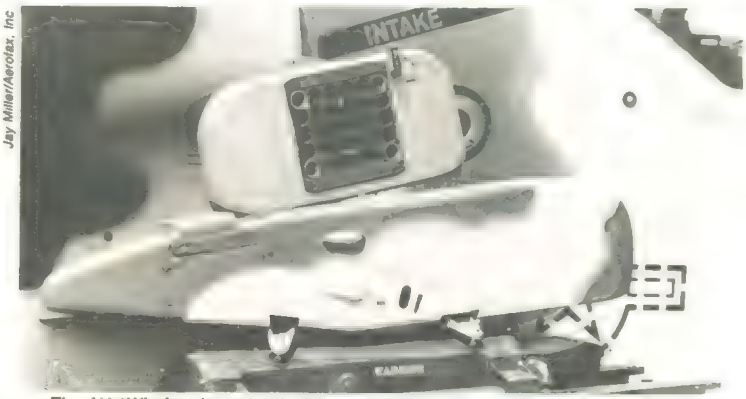




Jay Miller/Aerofax, Inc

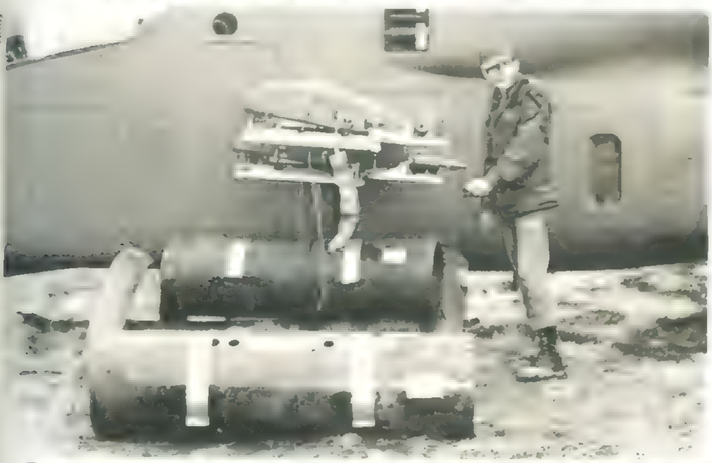
The AH-1W's stub-wings, like those found on the AH-1T, have a span of 11 ft. 7 in.; this differs from the 10 ft. 9 in. span wings of the AH-1S and the 10 ft. 4 in. to 10 ft. 7 in. span wings found on earlier AH-1G/Q "Cobras".

Jay Miller/Aerofax, Inc



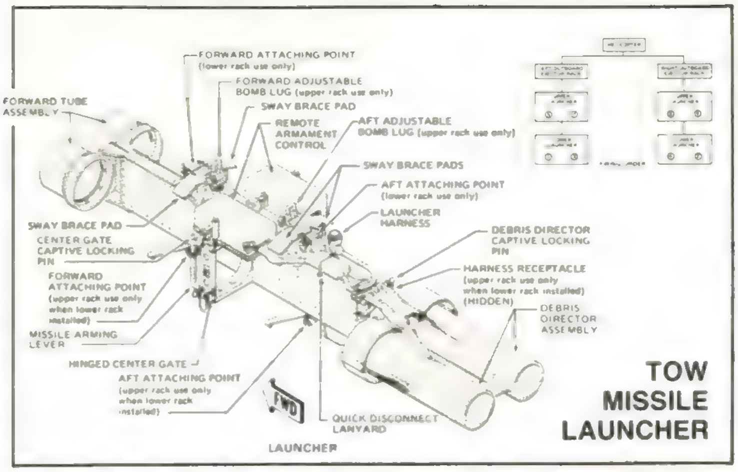
The AH-1W's four lower hardpoints are limited to 680 lbs. each. New upper surface hardpoints are available on the AH-1W and some AH-1Ts to accommodate AIM-9 and AGM-122 missiles. AH-1Ws carry one AN/ALE-39 chaff dispenser on each stub-wing.

Army

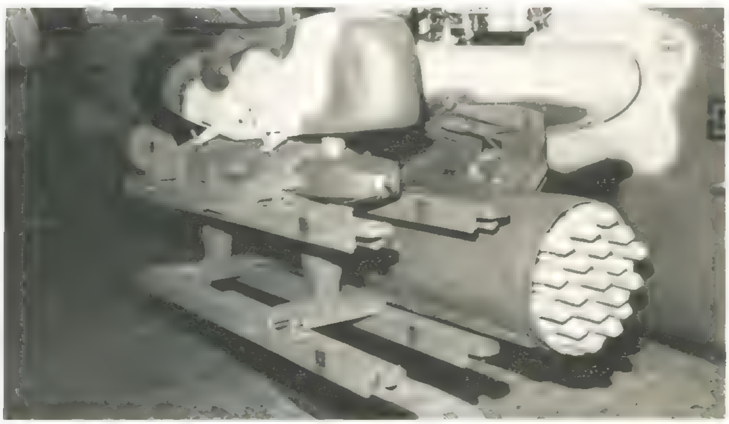


Army

Two, nineteen-round 2.75 in. FFAR pods could be mounted on each "Cobra" stub-wing in less than two minutes utilizing a hand operated winch system. A total of 76 rockets could be attached to the aircraft, using this system, in less than three and a half minutes. This was one of four experimental ammunition packaging concepts tested during the Army's MASSTER exploratory field exercises conducted during the late 1960s at the forward area refueling and rearmament point at Ft. Hood, Texas.

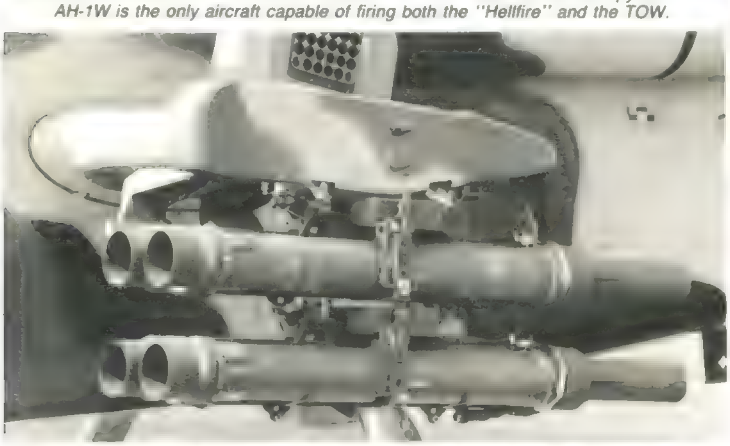


AH-1S stub-wing carrying a 19-round FFAR pod on its inboard pylon and a 4-round TOW tube launcher on its outboard pylon. Both the forward tube assembly and the debris director assembly (aft end) of the latter are visible.



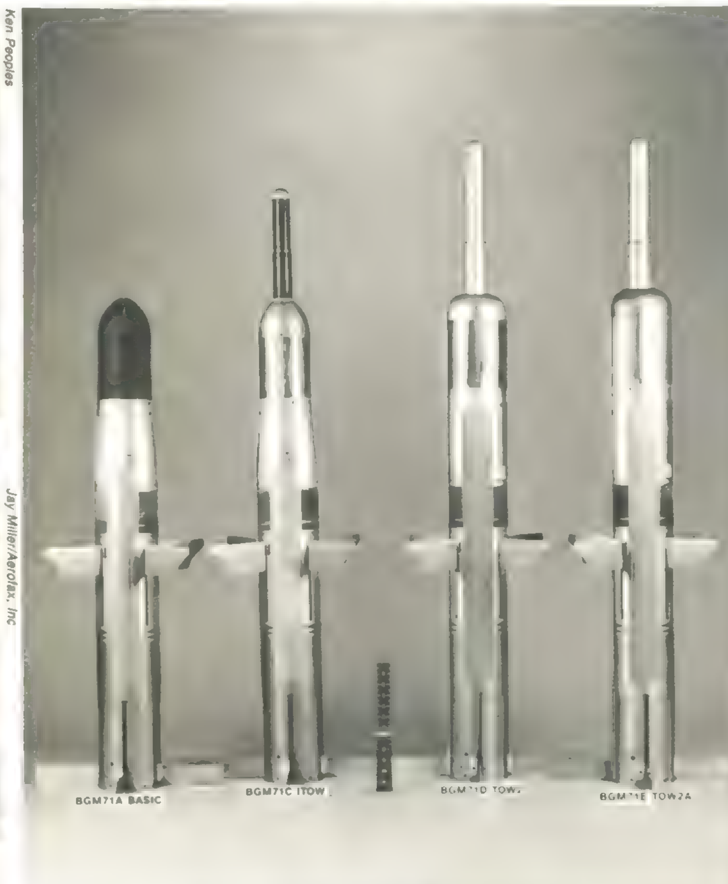
Ken Peoples

An AH-1W equipped with a fully-loaded 19-round FFAR pod and a four-rail "Hellfire" anti-armor missile rack. The latter is mounted on the articulated outboard pylon. The AH-1W is the only aircraft capable of firing both the "Hellfire" and the TOW.

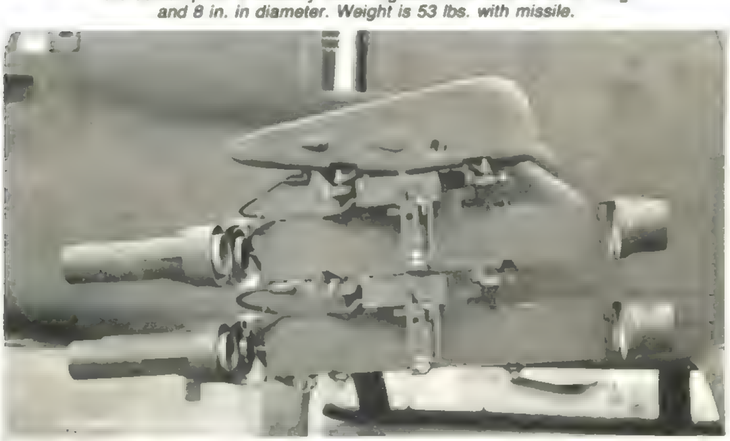


Jay Miller/Aerofax, Inc

The TOW launcher with missile tubes installed. The tubes, with missiles in place, are sealed prior to delivery from Hughes. Each tube is 50 in. long and 8 in. in diameter. Weight is 53 lbs. with missile.

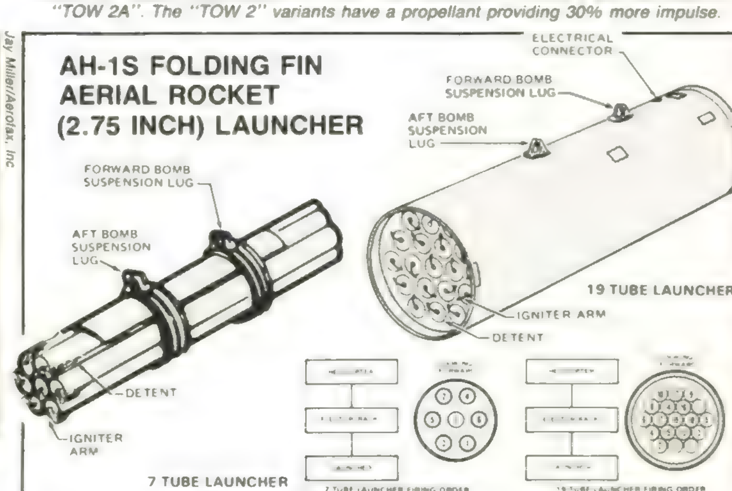


Four basic TOWs can be carried and fired by the "Cobra". From left, these include the BGM-71A "Basic", the BGM-71C "ITOW", the BGM-71D "TOW 2", and the BGM-71E "TOW 2A". The "TOW 2" variants have a propellant providing 30% more impulse.

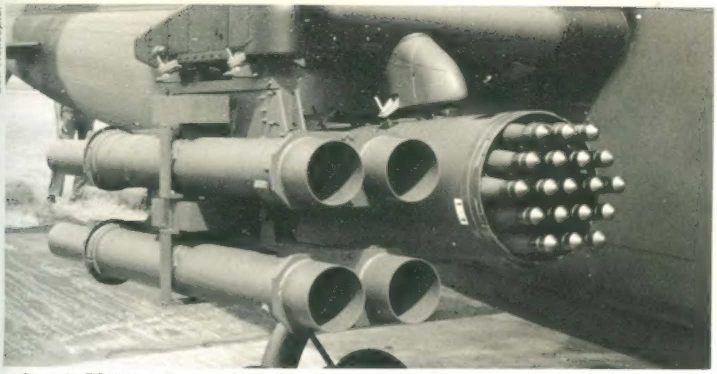


Jay Miller/Aerofax, Inc

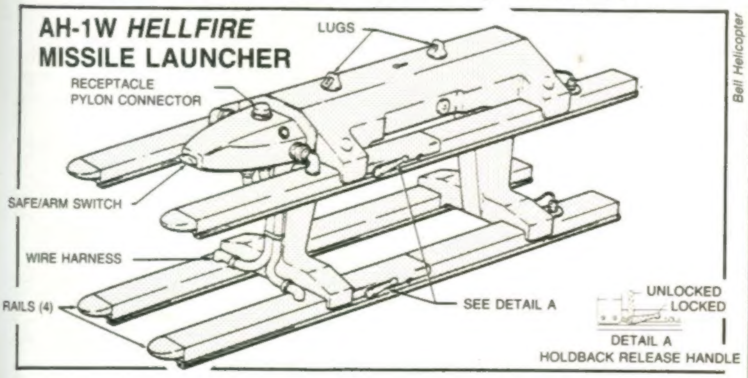
Empty TOW launcher mounted on the right outboard stub-wing pylon. TOW missile tubes lock into position and then are interfaced with the cockpit via electrical umbilicals. The conventional load is four missiles to be carried under each stub-wing.

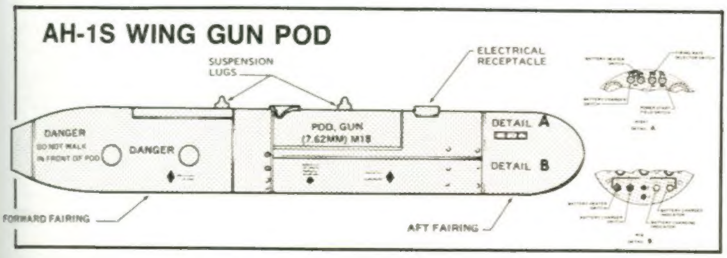


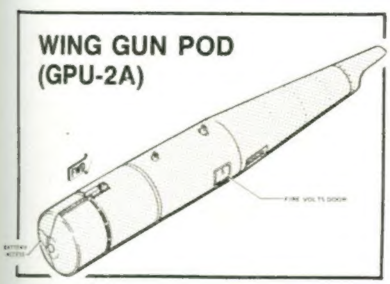
Bell Helicopter



An early TOW launcher configuration (and a conventional 19-tube FFAR pod) mounted on the first Model 309 "KingCobra". The TOW/tube package has a shelf life of approximately seven years and requires virtually no maintenance.







Jay Miller/Aerofax, Inc.

A rack of four Rockwell AGM-114 "Hellfire" missiles on an AH-1W. Initial AGM-114 trials were conducted on October 21, 1978 utilizing a JAH-1G. The AGM-114 is 5 ft. 4 in. long and 7 in. in diameter (tail span is 12.8 in.). The warhead weighs 20 lbs.

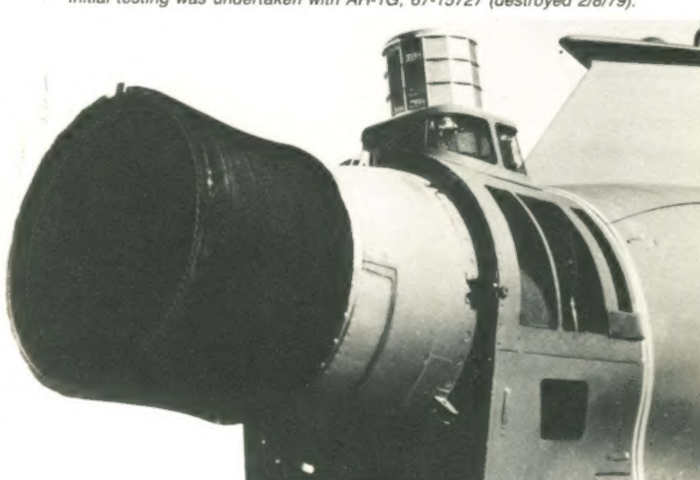
Bell Helicopter

Following booster rocket ignition and burn-out, the TOW is temporarily unpowered until the sustainer engine ignites. This unit, too, has only limited life, thus causing the major portion of the TOW's flight to its target to be unpowered.

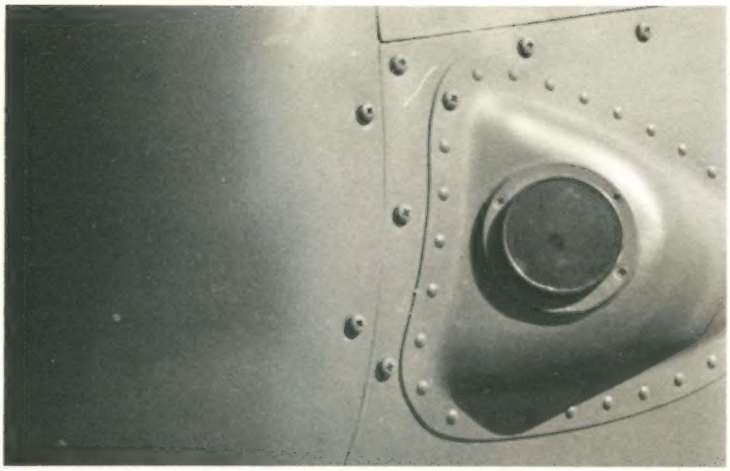
Bell Helicopter

A Sanders Associates AN/ALQ-144 i.r. jamming unit. The modulated i.r. heat energy generator was a then-state-of-the-art electrically heated cylindrical ceramic block. Initial testing was undertaken with AH-1G, 67-15727 (destroyed 2/8/79).

Bell Helicopter



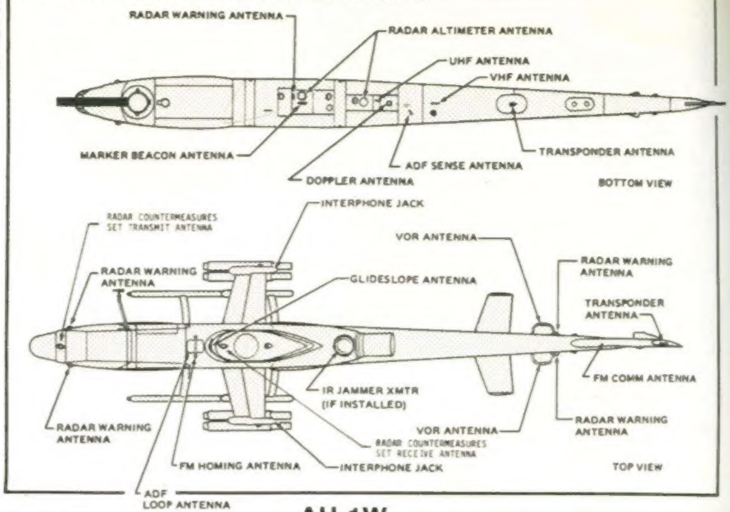
The AN/ALQ-144 infrared jamming unit is mounted above the i.r. suppressing exhaust nozzle fairing on the AH-1S. Newer i.r. jamming systems effectively have replaced this unit in Army service on newer helicopters.

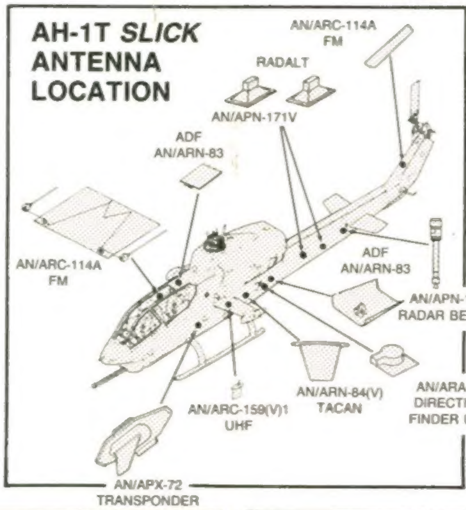


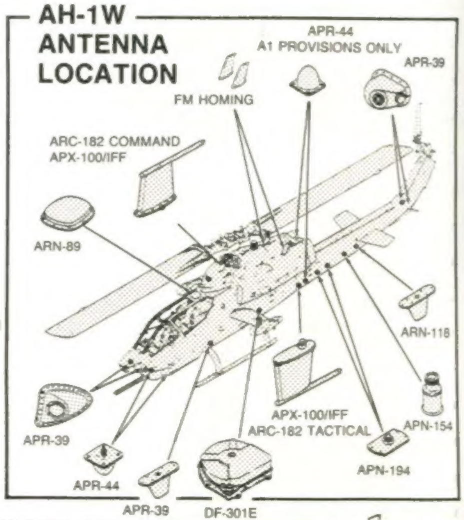
Ken Peoples

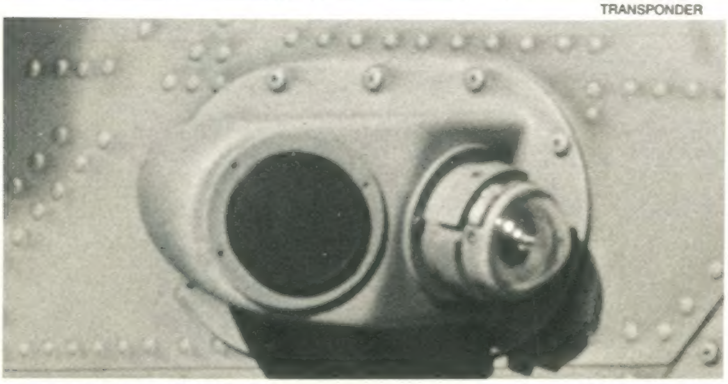
The E-Systems AN/APR-39 radar warning system covers all four quadrants of the aircraft. Threats and their bearings are indicated to the crew as strobe lines on a small, circular scope mounted on the aft cockpit instrument panel.

AH-1S ANTENNA LOCATIONS









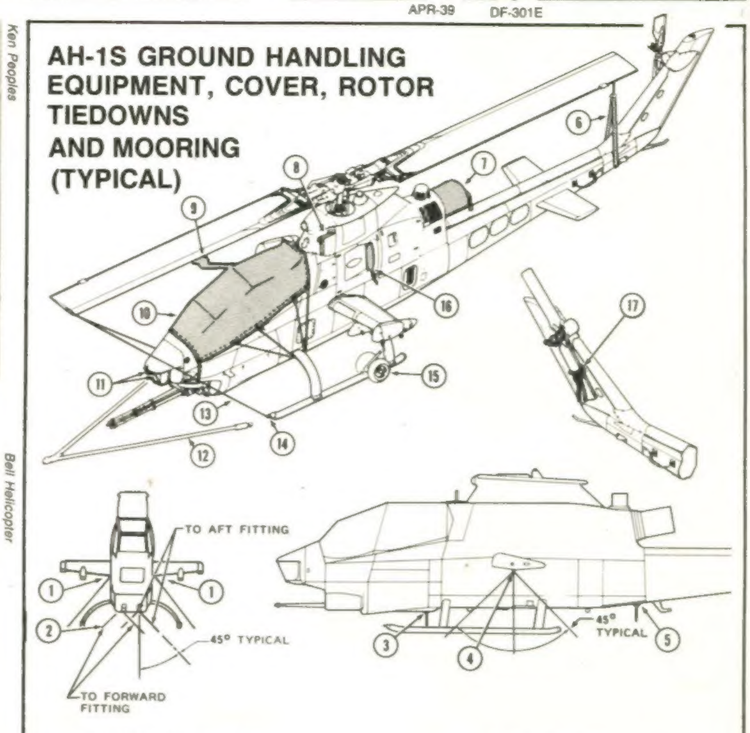
Ken Peoples

Four E-Systems AN/APR-39 antennas are mounted on the "Cobras" that utilize the system (an AH-1W is shown). Two are mounted on each side of the nose, and two are mounted on each side of the tail. Each is angled outward at approximately 45°.

Bell Helicopter

The Ford Aerospace ATAFCS pod was tested on an AH-1 during 1974. It combined TV, FLIR, laser transmitter/receiver capabilities, laser spot tracker capabilities, and automatic target tracking capabilities into a single unit.

AH-1S GROUND HANDLING EQUIPMENT, COVER, ROTOR TIEDOWNS AND MOORING (TYPICAL)



1. Additional tiedown rings at wing root
2. One inch rope or one-fourth inch cable
3. Forward mooring fitting
4. Outboard pylon mooring fitting (LH/RH)
5. Aft mooring fitting
6. Aft main rotor tiedown
7. Exhaust cover/IR duct cover
8. Pitot tube cover
9. ADS cover
10. Canopy cover
11. TSU covers
12. Tow bar
13. Forward main rotor tiedown
14. Tow ring
15. Ground handling gear
16. Engine air inlet shield
17. Tail rotor tiedown

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In general, however, our primary references are official, unclassified government documents, official, unclassified private sector (company) documents, and authoritative civilian publications such as *Jane's All The World's Aircraft* and "Aviation Week & Space Technology". Our photo sources consist primarily of contributions by professionals and amateurs from around the world, various government agencies, the aerospace industry, and our own in-house morgue.

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Jay Miller, Publisher

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AEROFAX looks forward to hearing from you.

Thanks for your interest,

Jay Miller and
the **AEROFAX, INC.** Staff

BELL AH-1 PRODUCTION/SERIAL NUMBERS

AH-1G Production Serial Numbers

Military Ser. No.	Qty.	BHT A/C No.	Contract No.
66-15246/47	2 Prototypes	20002/03*	DA23-204-AMC-04075
66-15248	1 Experimental	20004	DA23-204-AMC-04130
66-15249 thru 66-15357	109	20005 thru 20113	DA23-204-AMC-04130
67-15450 thru 67-15869	420	20114 thru 20533	DAAJ01-67-C-0043
68-15000 thru 68-15213	214	20534 thru 20747	DAAJ01-68-C-0469
68-17020 thru 68-17113	94	20748 thru 20841	DAAJ01-68-C-0469
69-16410 thru 69-16447	38	20842 thru 20879	DAAJ01-69-C-0252
70-15936 thru 70-16105	170	20880 thru 21049	DAAJ01-70-C-0236
71-15090 thru 71-15093	4	21050 thru 21053	DAAJ01-70-C-0236 (Spanish MAP)
71-20983 thru 71-21052	70	21054 thru 21123	DAAJ01-71-C-0724
72-21461 thru 72-21464	4	21124 thru 21127	DAAJ01-71-C-0724 (Spanish FMS)

*Note: A/C 20002/03 were basic test units. Production A/C 20004, 06, and 07 were used to support the test program.

Production Serial Numbers

AH-1P

Military Ser. No.	Qty.	BHT A/C No.	Contract No.
76-22567 thru 76-22610	44	24001 thru 24044	DAAJO1-76-C-0086
76-22692 thru 76-22713	22	24045 thru 24066	DAAJO1-76-C-0086
77-22729 thru 77-22762	34	24067 thru 24100	DAAJO1-77-C-0054

AH-1E

Military Ser. No.	Qty.	BHT A/C No.	Contract No.
77-22763 thru 77-22810	48	22101* thru 22148	DAAJO1-77-C-0054
78-23043 thru 78-23092	50	22149 thru 22198	DAAJO1-77-C-0054

AH-1F

Military Ser. No.	Qty.	BHT A/C No.	Contract No.
78-23093 thru 78-23125	33	22199 thru 22231	DAAJO1-77-C-0054
79-23187 thru 79-23253	66	22232 thru 22297	DAAJO1-79-C-0003
80-23510 thru 80-23521	12**	22298 thru 22309	DAAJO9-80-C-0427
81-23526 thru 81-23540	15**	22310 thru 22324	DAAJO1-81-C-0433
82-24065 thru 82-24076	12**	22325 thru 22336	DAAJO9-82-C-0675
83-24189 thru 83-24199	11**	22337 thru 22347	DAAJO9-83-C-B814

*Production Ship Nos. beginning with the AH-1Es were changed from 24 Series to 22 Series.

**Delivered to the Army National Guard (ARNG).

Production Serial Numbers

AH-1J

Bu Aer No.	Qty.	BHT A/C No.	Contract No.
157757 thru 157806	49	26001 thru 26049	DAAJO1-68-C-1929
159210 thru 159229	20	26050 thru 26069	DAAJO1-73-C-0320

AH-1T*

Bu Aer No.	Qty	BHT A/C No.	Contract No.
160105 thru 160114	10	26070 thru 26079	DAAJO1-75-C-0013
160742 thru 160748	7	26080 thru 26086	DAAJO1-77-C-0481
160797 thru 160811	15	26087 thru 26101	DAAJO1-77-C-0481
160812 thru 160826	15	26102 thru 26116	DAAJO1-77-C-0073
161015 thru 161022	8	26117 thru 26124	DAAJO1-77-C-0073

*All operational USMC AH-1Ts have now been modified to T(TOW) configuration. Conversion of the last batch of 28 aircraft was completed in December 1983 under contract No. N00019-81-C-0285.

AH-1W

Bu Aer No.	Qty.	BHT A/C No.	Contract No.
162532 thru 162553	22	26201 thru 26222	N00019-84-C-0002
162554 thru 162575	22	26223 thru 26244	N00019-85-C-0091
162576	1 (Trainer)	26245	N00019-85-C-0091

AH-1T/AH-1W MOD*

Bu Aer No.	Qty.	BHT A/C No.	Contract No.
160801	1	26901	N00019-84-G-0259

*Current plans call for the eventual conversion of 37 AH-1Ts to AH-1W configuration during the period 1987-1990.

AH-1 *Cobra* Foreign Military Sales

Nation	Model	Military Ser. No.	Qty.	BHT A/C No.	Contract No.
Spain	AH-1G	71-15090* thru 71-15093	4	21050 thru 21053	DAAJO1-70-C-0236
		72-21461 thru 72-21464	4	21124 thru 21127	DAAJO1-71-C-0724
Iran	AH-1J	3-4401 thru 3-4540	140	26501 thru 26640**	DAAJO1-73-C-0300 (28)
	AH-1J(TOW)	3-4541 thru 3-4602	62	29001 thru 29062	
Korea	AH-1J(TOW)	—	8	29063 thru 29070	75-3-AH-1J-8TW
Israel	AH-1Q	—	6	19291 thru 19296	77-3-AH-1Q/S
	AH-1E	—	6	21501 thru 21506	DAA-JO1-77-C-0416
	AH-1F	—	30	21701 thru 21730	500/01783-01-A-113 500/37092-01-A-113
Japan	AH-1E	—	1	21507	77-AH-IS-1-JPN
		—	1	21508	78-AH-IS-1-JPN
Jordan	AH-1F	82-24077 thru 82-24100	24	22601 thru 22624	DDA-JO9-82-C-B876
Pakistan	AH-1F	82-24055 thru 82-24064	10	22501 thru 22510	DAA-JO9-82-C-B874
		786-011 thru 786-020	10	22511 thru 22520	DAA-JO9-83-C-B812
Total:			306		

*Leased aircraft

**Note: Three aircraft (26502, 512, and 584) were subsequently modified to TOW configuration for test purposes.